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Assessing the impact of Information and Communication Technologies (ICT) on productivity in the hotel sector: an operations management approach

by

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ABSTRACT

Although investments in Information and Communication Technologies (ICT) are continuously increasing, the relationship between ICT and productivity has been very elusive. Indeed, despite the plethora of studies, research findings have always led to contradictory and/or questionable results. This has resulted in the development of a debate around the concept of the so called ICT productivity paradox. Recently, the issue regarding the productivity impact of ICT has been intensified due to the increasing role and penetration of ICT in the economy and their potential to create an equal competing field for all operators. However, it is widely recognised that there is a need to enhance our understanding of how ICT enhances productivity as well as to develop new techniques and methods for measuring, assessing and managing ICT for delivering organisational value. It is the aim of this study to investigate the impact of ICT on productivity by proposing and applying a robust methodology that is argued to overcome the limitations and problems of previous studies. By providing empirical evidence of the critical ICT issues that add organisational value, the research findings have also contributed in the development of a framework for managing ICT, which in turn raises more questions for further research and investigation.

The hotel industry is not an exception in such developments. ICT investments are increasing, however research on their impact on hotel productivity is lacking. To that end, the empirical framework of the study is placed within the context of the hotel sector. In particular, a mail survey targeting hotel managers of three star hotels was conducted for gathering data regarding productivity and ICT metrics. The latter were developed after conducting a thorough and systematic review of the literature regarding three core fields: a) productivity; 2) ICT; and 3) Data Envelopment Analysis (DEA). The latter is a multivariate statistical technique that was employed for carrying out enhanced statistical analysis of the productivity metrics, which were in turn investigated in their relationship with three ICT metrics. These were: a) type and amount of ICT applications; b) integration of ICT systems; and c) sophistication of use of ICT applications. Overall, 93 usable questionnaires were obtained, which provided the following main findings.

Although, a great variety of ICT has been adapted in three star hotel properties, operators are very limited in the way they exploit ICT tools and capabilities for enhancing their productivity. Specifically, very few hotel properties are deploying the networking/integration capabilities of ICT and so limit themselves to automating isolated work tasks and processes. Moreover, a great majority of respondents were found to be at the first stages of ICT implementation meaning that they mainly use ICT for automating their processing and not for exploiting the informational and transformational capabilities of ICT. On the contrary, findings provided evidence that productivity benefits are mainly attributed to ICT integration and sophistication of use rather than simple ICT availability. In this vein, in order to materialise ICT productivity benefits, an integrated approach for managing ICT should be adopted and implemented. Specifically, hotels need to manage and co-ordinate four components namely business processes, information, information systems and information infrastructure.

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AA	Arthur Andersen
ACD	Automated Call Distributors
ADR	Average Daily Rates
AH&LA	American Hotel & Lodging Association
APQC	American Productivity and Quality Center
ARR	Average Room Rate
ASP	Application Service Providers
ASP	Application Service Providers
ATM	Automatic Teller Machines
BHA	British Hospitality Association
BNR	Business Network Redesign
BPI	Business Process Improvement
BPR	Business Process Reengineering
CAS	Call Accounting System
CCR	Charnes, Cooper and Rhodes
CIOs	Chief Information Officers
CIS	Catering Information Systems
COLS	Deterministic Cost Frontier
CPO	Customer Processing Operation
CRM	Customer Relationship Management
CRS	Central Reservation System
CRS	Constant Returns to Scale
CSCW	Computer Supported Cooperative Work
DEA	Data Envelopment Analysis
DMS	Destination Management Systems
DMU	Decision Making Units
DP	Data Processing
DRS	Decreasing Returns to Scale
DSS	Decision Support Systems
EAI	Enterprise Application Integration
EDI	Electronic Data Interchange
EIS	Executive Information Systems
ENM	Energy Management Systems
EPOS	Electronic point-of-sale
ERP	Enterprise Resource Planning
ESS	Executive Support Systems
F&A	Finance and Accounting
F&B; FB	Food & Beverage
FF&E	Fixtures and Equipment
FO	Front Office
FTEE	Full Time Equivalent Employee
GDS	Global Distribution Systems
GUI	Graphical User Interface
HBR	Harvard Business Review
HR	Human Resource
IBC	International Benchmarking Clearinghouse
ICT	Information and Communication Technologies
IHRA	International Hotel and Restaurant Association

ioBPRR	inter-organisational Process Redesign
IPO	Information Processing Operation
IPS	Integrated Property System
IRS	Increasing Return to Scales
IS	Information Systems
IT	Information Technology
JIT	Just in Time
KM	Knowledge Management
LAN	Local Area Network
M&O	Material & Other
MIS	Management Information Systems
MPO	Material Processing Operation
MRP	Material Requirements Planning
NEDC	National Economic Development Council
NIESR	National Institute of Economics and Social Research
NIRS	Non-increasing Returns to Scales
OR	Operations Research
ORS	Optimal Returns to Scales
PABX	Private Automatic Branch Exchange
PARM	Perishable Asset Revenue Management
PC	Personal Computer
PDA	Personal Digital Assistants
PKF	Pannell Kerr Foster
PMS	Property Management Systems
ProfitPAC	Profit per available customer
PTE	Pure Technical Efficiency
RevPAR	Revenue per available room
RM	Relationship Marketing
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
SE	Scale Efficiency
SME	Small Medium Enterprises
SMSA	Standard Metropolitan Statistical Areas
SMTEs	Small and Medium Tourism Enterprises
SMTHEs	Small and Medium Tourism and Hospitality Enterprises
TE	Technical Efficiency
THISCO	The Hotel Distribution Switch Company
TPS	Tourism Production System
TQM	Total Quality Management
UK	United Kingdom
USA	United States of America
VRS	Variable Return to Scales
WAN	Wide Area Network
WBT	Web Based Training
WTO	World Tourism Organisation
WWW	World Wide Web
YM	Yield Management

CHAPTER ONE

Introduction

1. Introduction

Businesses' spending in Information and Communication Technologies (ICT) is continually increasing. Indeed, as participants of the International Hotel and Restaurant Association (IHRA) IT Think Tanks (IHRA, 2000) reported, ICT now ranks among the largest capital expense items and will continue to remain so as hospitality firms seek new and creative ways to exploit the growing capabilities of ICT. That was also confirmed by the research findings of the Hotels' magazine worldwide study on ICT in hotels that revealed that spending on ICT has substantially risen between 1997 and 2000, since greater percentages of hotels are found in the higher spending categories in 2000 than in 1997, either in terms of amount of funds spent (Table 1.a) or in terms of the percentage of revenue spent on ICT (Table 1.b), Marsan, 2001).

Table 1.a Dollars spent on ICT during the last five years and dollars planned to be spent on ICT during the next five years (at the property level), % of respondents

	Study conducted on 1997		Study conducted on 2000	
	Last five years	Next five years1	Last five years	Next five years2
Less than $50,000	20%	14%	16%	11%
$50,000 – $249,000	38%	38%	39%	40%
$250,000 - $499,999	16%	22%	19%	21%
$500,000 or more	20%	19%	24%	21%

1= 6% did not answer the question
2= 7% did not answer the question
Source: Marsan (2001)

Table 1.b Percentage of gross revenues spent on ICT during the last five years and percentage of gross revenues planned to be spent in the next five years (at the property level), % of respondents

	Study conducted on 1997		Study conducted on 2000	
	Last five years	Next five years1	Last five years	Next five years2
Less than 1%	21%	11%	13%	10%
1% - 1.9%	30%	21%	35%	21%
2% - 2.9%	24%	33%	16%	21%
3% - 3.9%	13%	21%	8%	17%
4% - or more	8%	8%	24%	27%

1= 6% did not answer the question
2= 5% did not answer the question
Source: Marsan (2001)

On the other hand, despite the increasingly high ICT investments, findings of studies investigating the ICT productivity impact have always led to contradictory and/or questionable results, which in turn have perplexed managers and researchers as to whether the expected benefits of computers have materialised. Robert Solow, a Nobel winning economist, is supposed to have said that *"PCs are showing up all over the place, except in productivity statistics"*, (in Lucas, 1993: 8), while Brynjolfsson (1993) first referred to the concept of the "IT productivity paradox", i.e. the fact that the benefits of IT spending have not shown up in aggregate output statistics. However, this may be due to methodological issues as several methodological shortcomings have been identified in past studies. In this vein, new IT evaluation methodologies are required to lessen or eliminate these problems.

In a recently IHRA published White paper on the future of the international hospitality industry (Olsen, 1996), ICT were identified as one of the five key themes driving change in the hospitality industry. ICT are drastically altering the competitive landscape of the hospitality industry and rewriting the rules for how hotels conduct business and reach their customers and coupled with the increasing spending and importance of ICT in the tourism and hospitality sectors, it becomes apparent that an investigation into the impact of ICT on productivity is warranted.

Specifically, in the hospitality and tourism industry, research on the relationship between computers and labour is characterised by the lack of research. Indeed, after illustrating that the weakest area of productivity literature in service industries is the role of technology, Baker and Riley (1994) also argued that this is the one area of research that would advance knowledge of hotel productivity. Moreover, following the findings of recent studies (e.g. McKinsey Global Institute report, 1998) revealing very low productivity levels in the UK hotel industry relative to its international competitors, the importance of productivity measurement, management and improvement has become a vital and crucial issue. In the same vein, participants of the IT Think Tank (IHRA, 200) advocated that hotel bottom-line performance will be more closely scrutinised, with little to no tolerance for disappointing results. Undoubtedly, in an ever-increasing hypercompetitive marketplace, industry stakeholders and investors are placing greater emphasis on value and return on investment. Thus, there is a great need for the industry to begin to benchmark its performance in order to advance and evolve a universally recognised best practices operating standard.

Participants of the IT Think Tank (IHRA, 2000) also recognised that IT investments and practices in the hospitality industry have been inhibited by the ability of managers to assess the impact of IT on firm's productivity and profitability and so they argued that future research should aim at proving and assessing the IT impacts while also moving forward by indicating how and where hospitality firms allocate resources to ensure long term productivity gains. Connolly (1998) revealed that 90% of hotels' Chief Information Officers (CIOs) claimed that they did not know how to measure the leverage that ICT was creating although more than half believed that their ICT investments were enhancing firm performance. Farbey (1999) also argued that weak theoretical and empirical methods exist regarding evaluation of the business value of ICT investment. In this vein, managers are faced with investing in ICT based on a "gut feeling" that value will ensue, without having good measures to determine the performance effects. However, as Brynjolfsson (1993) noted productivity is an economic measure of the contribution of technology and so productivity must be a relevant and appropriate performance measure for evaluating investments in ICT.

According to Berger et al (1991, p. 64) there are five specific reasons for identifying the business impact of ICT:

1. To help businesses in the IT investment decision process and in priority setting;
2. To communicate IT value to business and operating management; it is important to see what value if any IT delivers;
3. To help rationalise the allocation of company's assets;
4. To help management decide on business actions that include IT;
5. To demonstrate that IT is part of the mainstream of business activity.

To that end, the primary aim of this study is to investigate the impact of ICT on productivity in the hotel sector by proposing and using a methodology that it is argued to overcome the methodological shortcomings of previous studies. To achieve this, a productivity benchmarking study across three star hotel companies with different ICT configurations was carried out using the Data Envelopment Analysis (DEA). By establishing a benchmark across hotel companies the study also identified best practices, which can then be used by hotel operators in order to upgrade and leverage their ICT capabilities. Specifically, the benchmark study distinguished high performers from inefficient hotels as well as identified the ways in which ICT resources are being exploited and leveraged.

To overcome previous methodological shortcomings as well as to base the study on a sound theoretical basis, a wide literature (regarding both productivity and ICT issues) was reviewed. The specific fields that were studied, their contribution to the study and the issues and concerns that they raised are summarised as follows. This structure of the thesis is also mapped in Figure 1.a.

Chapter two aims at providing an analysis of the definition and measurement of the productivity concept in general and in the hotel sector in particular. In this context, an attempt to define and conceptualise productivity was attempted by identifying its components and dimensions. Productivity definition is important because it affects the way productivity is operationalised and measured. Thus, the review discusses and illustrates the process and issues in terms of productivity measurement while highlighting the limitations and advantages of different productivity measurement techniques. Moreover, the factors affecting productivity as well as several productivity metrics used in previous studies are identified and discussed.

In Chapter three, the investigation and analysis of relevant theories regarding how productivity can be improved are reviewed and discussed. Ultimately, an operations management theory, namely the performance frontiers theory, is adopted, since: a) it unifies in a sound framework, arguments and theories from different disciplines; and b) there is a statistical and methodological way for testing its hypotheses, i.e. the production frontiers function on which the DEA methodology is based.

Based on the findings of Chapters two and three, the DEA methodology for measuring, identifying and explaining productivity differences based on the performance frontier theory is chosen. To that end, Chapter four explains DEA, identifies its advantages for productivity benchmarking as well as illustrates the way it can be applied and the type of data analyses that can be conducted.

Chapter five concentrates on the ICT concept explaining what ICT are and how they can impact on productivity. To that end, ICT are defined by identifying and explaining their constituent and continually evolving components, capabilities and features. Moreover, the way that the latter impact on the hospitality industry and performance dimensions are analysed, while several arguments and theories regarding how ICT can improve productivity are reviewed. Ultimately, the chapter develops and argues a new approach and framework for identifying the potential impact of ICT on productivity, which takes into account the evolving ICT capabilities and tools. Based on this approach, a framework that is argued to identify different levels and uses of ICT that lead to different productivity gains is developed and adopted for measuring

ICT investment applications and developing hypotheses in terms of their impact on productivity.

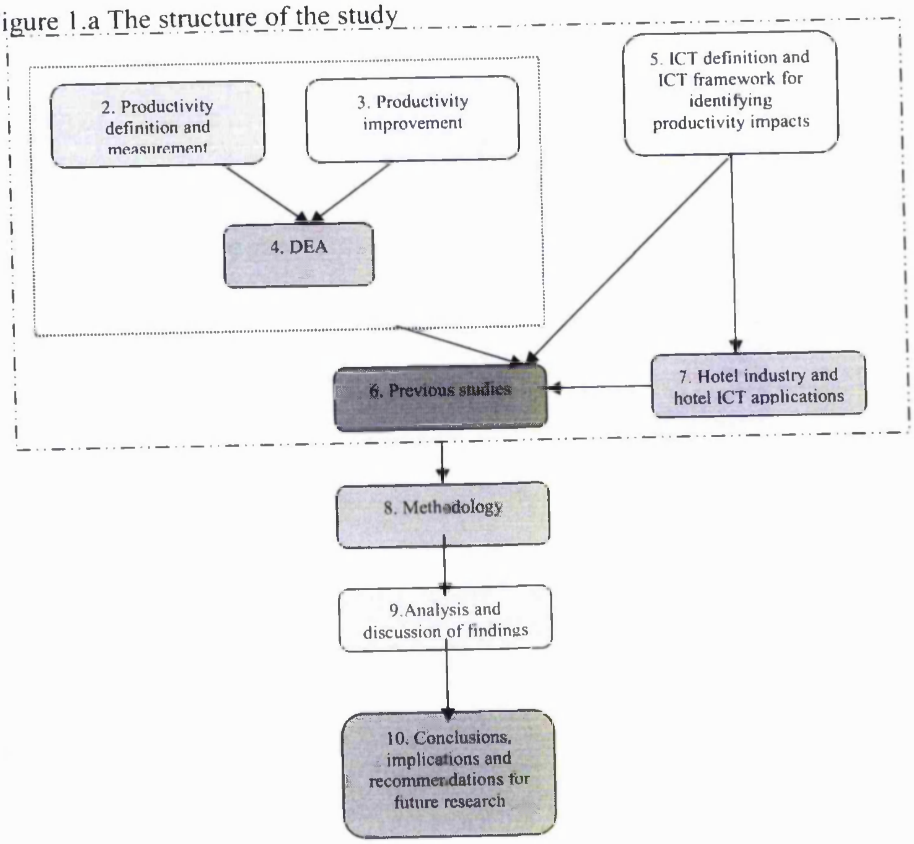
Chapter six reviews previous studies investigating the productivity impact of ICT and coupled with the literature review provided in previous chapters it critiques their reliability and validity. In this context, methodological shortcomings and concerns are identified and analysed, which in turn were used for building a robust methodology for this study.

Chapter seven aims at developing and analysing the contextual framework in which this empirical study was conducted, i.e. the three star hotel sector. Specifically, the business of a hotel is defined, while an insight into the hotel sector in terms of its structure, type of operators and their operating characteristics is provided. A particular emphasis is given on the characteristics of three star hotel properties. Moreover, the hotel sector is analysed in terms of its adoption and use of ICT tools. Regarding the latter, hotel ICT applications and their impact on productivity are discussed by highlighting how, according to the previously identified model, their different implementation and use (i.e. integration and sophistication of use) can enable different operations and so different productivity gains. Overall, this analysis provided a great help in developing the research method and instrument.

Chapter eight deals with how the methodology of this study has been developed and justifies its robustness relative to that of previous studies. The chapter begins by indicating the aims and objectives of the study, which are followed by an analysis of the methodology that has been developed to meet these objectives.

Chapter nine presents and discusses the study's findings, while in chapter ten the conclusions, implications and recommendations of this research are drawn.

Figure 1.a The structure of the study



CHAPTER TWO

Productivity definition and measurement

This chapter aims at investigating how productivity is conceptualised. Although the productivity concept originated from the manufacturing sector, productivity has also been applied and used in the service sector. The specific characteristics of services and how they affect productivity definition and measurement are reviewed. In summary, the different approaches and dimensions of productivity are identified and reviewed, while an overall framework summarising them as well as illustrating their interrelationships is analysed.

The second part of the chapter attempts to identify ways in which productivity can be measured. The particular problems of productivity measurement are identified and explained. It emerges that the way in which productivity is conceptualised affects productivity definition and improvement practices. The process of productivity measurement is summarised in a number of steps, while the issues and problems concerning each step are analysed.

The third part of the chapter identifies the specific factors that can affect productivity in the hospitality sector. There is also a review of the metrics used in productivity measurement in previous studies. The chapter ends with a brief summary of the key issues that emerge from this review. It also identifies how this study has addressed these issues on productivity.

2.1 Defining productivity

2.1.1 Introduction

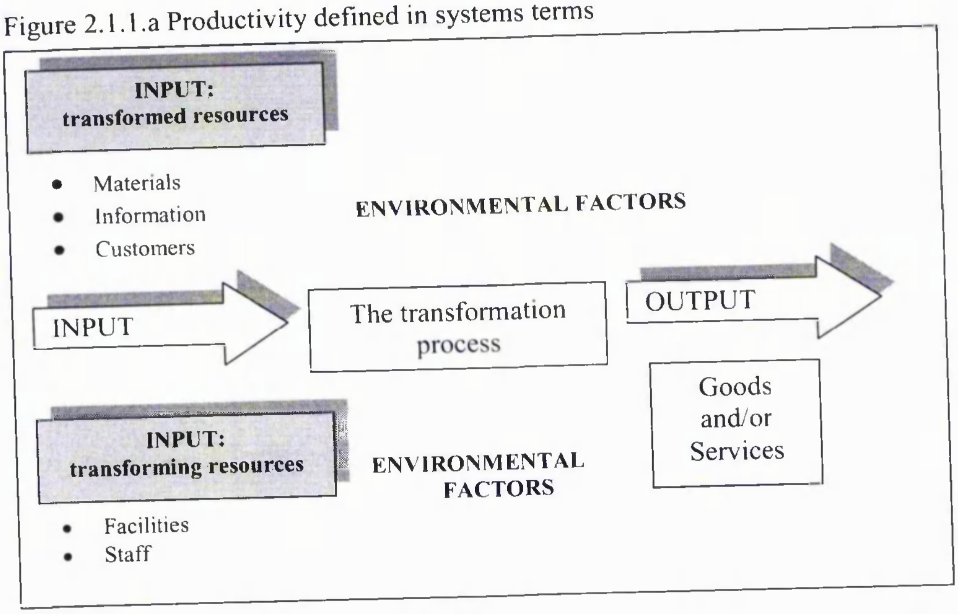
Productivity, in a general sense, has been an important issue since the early days of management theory both in the manufacturing and services sector. In his seminal work in the scientific approach to management ("The Principles of Scientific Management", 1911), Taylor stressed the concepts of efficiency, predictability and calculability. Nevertheless, since services have elements of manufacturing in themselves, the manufacturing construct of productivity, modified to take into account the differences between making products and delivering services, has also been applied to service industries, (Jones and Hall, 1996). Indeed, efficiency and predictability issues are the focal points of Ritzer's concept of McDonaldization, while Levitt (1976) talks explicitly about the "industrialisation" or "production-lining" of service citing the fast food service industry.

Schroeder (1985) defined productivity as the relationship between inputs and outputs of a productive system, which is compatible with Moorhead and Griffin's definition (1992, p. 44), i.e. *"productivity is an indicator of how much an organization is creating relative to its inputs"*. This meaning of productivity as a "faculty to produce" is also reflected in dictionary definitions of productivity that are mainly based on economic theory principles. So for example, Chambers' dictionary defines productivity as *"the rate of or efficiency of work, especially in industrial production"* while Oxford dictionary defines productivity as *"the arithmetical ratio between the amount produced and the amount of resources used in the course of production"*.

Thus, in a broad sense, productivity is regarded as the utilisation of resources in creating goods or services from an entity. In this sense, an organisation or firm can be simply viewed as a microeconomic system. According to systems theory, it is an open system, since organisations are in constant interaction with their environment. So, resources are taken from the environment and used as inputs to the organisation, which in turn by interacting with each other are transformed to produce outputs that return to the environment. Transformation is thus the process of using the systems' inputs to change the state or condition of something to produce outputs (Slack, 1995, p.11). Systems inputs may be classified into "transformed resources", i.e. the resources that are treated, transformed or converted in some way such as customers, information and materials, and "transforming resources", i.e. the resources that act upon the transformed resources, namely facilities and staff. Thus, productivity is defined in systems terms as the relationship between the amount of output of goods and/or services obtained from a system and one or more of the input(s) employed in yielding this output (Figure 2.1.1.a).

The transformed and transforming resources are resources that can be controlled or determined by managers in order to adapt and take advantage of the constantly changing environment and so they are referred to as controllable inputs to the transformation model (Anderson et al, 1997). Because managers have a choice of controllable inputs, the latter are also referred to as decision variables or discretionary variables. In reality though, there are also exogenously fixed or nondiscretionary inputs that can influence productivity and which are beyond the control of a firm's management and so uncontrollable. These uncontrollable variables are either factors determined by a company's market area (e.g. location of a hotel) or by the physical characteristics of the property (e.g. number and mix of rooms) and they are more or less exogenously fixed in a sense that they cannot be changed by the management. In Figure 1.1.a the uncontrollable factors are illustrated by the environmental factors.

Figure 2.1.1.a Productivity defined in systems terms



$$\text{Productivity} = \frac{\text{Output obtained}}{\text{Input (s) employed}}$$

Source: Slack et al (1995)

Considering productivity in the hospitality industry, several writers based their recommended approach on this original concept. Dilworth (1989) defined productivity as the ratio of all outputs over all inputs, while Rose (1980) referred to the measurement of resources needed to produce an identified output. Bain (1986) argued that although the concept of productivity tends to be associated with manufacturing, it can be applied to other situations where there is a lot of tangible physical output, by giving a simple example of a car's miles per gallon rating: the fuel is the input, and the distance travelled is the intangible output. If intangible but measurable inputs and outputs are used, the concept of productivity can be applied to education, government, the professions and the service sector generally. Jones and Hall (1996) also argued that the current thinking of productivity stems from and is a construct of the "manufacturing paradigm" developed during the Fordist period, whereby the main focus is on mass production and consumption of as many identical products as possible, that is controlled along Taylorist scientific principles and along production lines of semi-skilled workers.

However, although the concept of productivity seems to receive approval from everyone, it is still rarely that productivity has been defined satisfactorily (Boley et al, 1986). Indeed, productivity means different things to different people (Prokopenko,

1987) and in reality, quite a few disagree with the basic meaning of productivity advocating different (Mohanty and Rastogi, 1985; Sink, 1985; Thorpe, 1986; Prokopenko, 1987; Pickworth, 1994) or even conflicting (Thorpe, 1986; Pickworth, 1987) definitions and perceptions of productivity. Such claims are logical given that people have varying backgrounds, positions of responsibility, goals etc. According to Ball and Johnson (1989 and 1994) and Pickworth (1987), the way people conceive productivity and set about improving it is largely a reflection of their disciplinary predispositions, e.g. management or behavioural science or economics. So, to some, productivity is mostly a matter of time-and-motion studies and of investing in labour-saving equipment, while to others, it is more an issue of training, monetary incentives and management style. In this vein, Pickworth (1987) advocated the need for a more holistic approach to defining productivity.

Thus, the problem of productivity definition and complexity in the hospitality industry remains. Heap (1992, p.3) commented that *"most people when faced with the term have some understanding of its use but would be hard pressed to offer a definition"*, while Medlik (1989) related productivity virtually solely to labour productivity (e.g. number of covers, number of guest visits) per work hour. However, the limited, or lack of, understanding of even the basic productivity concept has restricted productivity measurement and management in hospitality organisations (e.g. Lane, 1976; Ball, 1996).

Although the basic productivity concept is always the ratio of output to input, i.e. a simple equation of resource conversion, its definition can be simple to state, but it is complex to apply, particularly in the hospitality service context (Jones, 1990). According to Ball (1996), the traditional productivity concept is based on two assumptions, which are imperfect when applied to the realities of the hospitality industry. First, the inputs and outputs are perfectly defined and measurable. Second, the utility of outputs is in no doubt. The difficulties in defining and measuring productivity in the hospitality context mainly stem from the specific features of services that distinguish them from manufacturing, where the concept of productivity originated. Indeed, Rimmington and Clark (1996) argued that depending on whether services' features are taken into consideration two perspectives of defining and operationalising productivity are identified namely, the quantitative and total factor approach.

2.1.2 Service perspectives of productivity

Several authors (e.g. Jones and Lockwood, 1989; Witt and Witt, 1989, Jones, 1988) advocated the complex nature of productivity in the service sector arguing that the evolution of a universally accepted definition of productivity has been limited by the features and characteristics of services. The commonly cited aspects of services influencing the complexity of productivity, and so its measurement and management, are as follows (Sasser et al, 1978):

- intangibility refers to the problem of being able objectively to define and measure the service outputs being provided; for example, hotel outputs are a complex mix of tangible, e.g. number of guests nights, and intangible factors, e.g. responsiveness and helpfulness of the staff. The difficulty in identifying and quantifying what customers value from the complex mix of tangible goods and intangible services creates problems in measuring productivity as the ratio of input to output. Measurement problems create difficulties on productivity control and improvement;

- heterogeneity suggests service encounters are experienced differently by different people or even by the same people at different circumstances. Thus, the measurement of the output is almost impossible as each customer purchases in effect a unique "experience". Thus, any attempt to increase productivity is very likely to impinge upon customers' perceptions of the service offered (Ball and Johnson, 1989);
- simultaneity means that in services production and consumption occur at the same time. This makes the production activity difficult to schedule. Peaks and troughs as a result of the customer-driven demand lead to relatively unproductive slack time. The simultaneous production and consumption of services also means that there is no room for errors highlighting the need for delivery quality assurance;
- perishability relates to the issue of the immediacy of consumption of the service product and refers to the problem that services are difficult or impossible to store; so, an unsold room is a sale lost for ever. The inability to hold stock hinders the management of fluctuating demand, and prevents buffering, which is heavily used in the manufacturing sector for addressing the scheduling problem. Hence, the control of quality and match of supply to demand are the key management problems in services, which are often exacerbated by the presence of the customer during the service delivery process.

Thus, although the definition of productivity is simple to state it is significantly difficult to apply in the context of service industries in general and in the hotel sector in particular. In summary, there are a very large number and variety of inputs/outputs that occur in the daily operation of a hotel operation, which are made up of tangible and intangibles. However, one of the reasons why it is difficult to standardise all inputs and to guarantee their impact on outputs is that the intangible components are complex and difficult to control. Moreover, intangibility problems coupled with heterogeneity and simultaneity problems further create operational challenges. So, in a hotel stay, only the physical items can be easily measured and controlled, while many of the other features of the hotel experience, such as service and atmosphere are intangible. Moreover, because each transaction with each customer can be regarded as unique and can differ between customers but also with the same customer over time and in different circumstances a quality challenged is created, i.e. each service encounter needs to be customised to meet the needs of that customer at certain times and circumstances. However, this in turn creates a perishability problem as it entails the creation of unique sets of inputs/outputs ratios for each encounter whereby productivity control becomes very difficult.

Hence, Jones and Lockwood (1989) explained that productivity measurement and management in services is extremely difficult because:

- inputs and outputs are difficult to standardise (mainly due to the unique nature of service transactions);
- input/output relationships are not constant (i.e. not standardised between units or departments);
- inputs and outputs may be difficult to measure (due to their variability and intangibility).

Overall, intangibility and heterogeneity present problems of productivity measurement while simultaneity and perishability present problems of productivity management and improvement (Jones and Hall, 1996). However, these features are not separate in nature, but co-exist within most services. That is to say services vary from one service encounter to the other (heterogeneity) largely because they depend on the interaction of the consumer with the service provider (simultaneity), providing "something" that the user cannot easily objectively measure (intangibility), which makes it almost impossible for the service provider to store (perishability), (Jones, 1988).

Productivity measurement and management is further complicated by the fact that there are very few "pure" services or indeed pure manufacturing processes. Several authors have tried to conceptualise the distinction between products and services. According to Sasser et al (1978), most services and products lie along a service/product continuum, while Foxall (1983) argued that those who argue for clear cut distinctions between services and products have actually demonstrated no more than if some services are located at or near one end of various continua, then some "products" can be logically placed at or near the opposing poles.

Levitt (1972) argued that the most important distinguishing factor of products and services is the level of intangibility, but as the continuum indicated, it is almost impossible to measure the level of tangibility, which in turn can also vary from experience to experience; e.g. one day a customer may use a restaurant to enjoy the meal (product), the next to partake of the friendly service (service). Moreover, Jones and Hall (1996) claimed that it is insufficient to think of the hospitality provision simply in terms of manufacturing and service or in terms of a manufacturing-service continuum, since both manufacturing and service operations process some combination of three principal elements: materials, information and people. On the other hand, since the defining and distinguishing feature of service industries is the direct involvement of the customer with the service provider (the service encounter), which considerably impacts on productivity (Czepiel et al, 1985, Mill 1989), Jones and Hall (1996) proposed a "neo-service paradigm" centred on customer processing operations and supported by a model of productivity retitled "servicity". However, ways of measuring this productivity concept have still to be developed.

Shostack (1977) proposed that rather than categorisations, each service/product should be considered as a molecular model being made up of a tangible or intangible nucleus surrounded by additional tangibles or intangible elements. Such an approach seems more appropriate considering the convergence of goods and services that ICT applications have fostered within the knowledge economy. Indeed, a re-conceptualisation of the meaning of the terms "product" and "production" is taking place. So, although in the old economy, people bought and sold "congealed resources"- a lot of material held together by a little bit of knowledge, in the new economy, people buy and sell "congealed knowledge" – a lot of intellectual content in a physical slipcase (Steward, 1999, p.16).

For example, Amazon.com redefined and extended the sale or even the production of books beyond the simple maintenance of books' inventories. When Amazon.com sells a book, information is gathered, stored and furthered analysed for facilitating future sales (e.g. target the same customer with similar books, cloning customer profile to target similar prospects), while virtual communities and online forums are being exploited for identifying topics for future books. Customers are also visualised to be able to design the content of a book they want to read (simultaneously consumption and production). In this vein, the sale or production of a book entails a complex process (different from the classical approach to manufacturing processes) that exploits and transforms information resources and then encloses them into a physical element (congealed knowledge). Similar concepts have been applying in the tourism and hospitality sectors for years. The Global Distribution Systems (GDS), initially developed by airlines for facilitating their distribution/marketing processes, sell services that enclose and exploit a vast amount of customer intelligence and nowadays, the value of some of these systems is greater than that of their parent airline company. Hotel companies have also realised that hotel operations are more than cleaning and making a room available and have seriously started to apply customer relationship management practices.

As services entail several tangible elements while "products" are being informalised with intangible elements, the distinction between services and products blurs. The question then arises on whether productivity should be defined, measured and managed differently in the manufacturing from the services sector. Moreover, the basic definition of productivity rooting from the manufacturing sector possesses applicability difficulties in itself.

2.1.3 Quantitative versus Total Factor approach to productivity definition

In response to the difficulties in identifying and measuring inputs and outputs, two approaches to productivity definitions have been developed namely the quantitative and total factor approach.

From a quantitative approach, productivity is viewed at its simplest level expressed as the ratio of output to input, similar to ratios that measure efficiency (Heap, 1996, p. 3, Conlin and Baum, 1995, p. 55). By providing several examples (Figure 2.1.3.a), Heap (1992) demonstrated how inputs and outputs can be specifically identified and measured financially to provide a quantitative perspective.

Figure 2.1.3.a Productivity measured quantitatively

Examples of	**Value of inputs** ↓ Labour, Funds, Materials, Energy, Capital equipment	and	**Value of outputs** ↓ Products and services

Source: Rimmington and Clark (1996)

Financially measured inputs and outputs can also be compared at a broad aggregate level by measuring the value added, i.e. the difference between the value of outputs and the value of inputs. The higher the value added, the higher the productivity, i.e:

Value added = value of outputs – value of inputs

Medlik (1988) defined the value added by an individual business as the total value of sales less the cost of purchases of materials and services from others. In most businesses, this equals sales less expenses other than payroll or payroll plus profit. Thus, value added is the return to labour and capital after payments to suppliers are made.

Such quantitative measurement is straightforward because only readily available and objective criteria of financially measurable, tangible inputs and outputs are considered.

Moreover, many authors (e.g. Jones, 1990; Heap, 1992; Andersson, 1996) argued that as services are an amalgam of tangible and intangible elements, partial productivity metrics based solely on tangible elements are not able to capture and describe the content of a "service" output. In addition, if a long-term view is taken, the intangible customer satisfaction is perhaps the most important service experience output. Thus, because intangible factors such as atmosphere, management style, staff flair and expertise, are an intrinsic part of the service experience, they are undoubtedly very important elements in both productivity inputs and outputs. So, a multi-factor (Chew, 1986) or total factor view to productivity is proposed in order to take into account the structural complexity of hospitality outputs/inputs, recognising the typical intangibility, perishability, heterogeneity and simultaneity characteristics of services (Mahoney, 1988).

Productivity becomes even more complex when one also examines the array of factors that face managers attempting to enhance their companies' performance, e.g. increase production, lower costs or develop some combination of the two. However, when the focus is on the end results without much consideration for the total environment that these variables operate in, productivity definition is a simple task (Conlin and Baum, 1996, p. 55). For example, the contemporary human resource management literature provides the following examples:

"in simple terms, productivity can be defined as output per hour. But this is far too simple. Productivity comes in various forms . . . some define productivity as the change in unit labour costs, or how much each item costs to produce. Others suggest that productivity is the value of production over paid hours"

(Anthony, Perrewe and Kacmar, 1993, p. 352)

It has though been argued that specific factors driving such final results acknowledged as "upstream" factors (Rimmington and Clark, 1996; Clark, 1994) or "top-line" factors (Heap, 1992) should be included in productivity definition, measurement and monitoring. The inclusion of such factors is advocated by the total factor approach.

However, conflicting views exist not only regarding productivity definition but also regarding the interpretation of the approaches to productivity definition. So, some argue that a total factor productivity refers to the consideration of both of intangibles and tangible inputs and outputs, others use the term within the context of the financial/quantitative approach. For instance, Ball et al (1986) interpreted the total factor approach to involve the generation of broad aggregate measures that intrinsically encapsulate all individual (partial) aspects of productivity, i.e. labour, energy, capital or raw material.

In fact, such interpretations develop around the two forms in which the basic productivity concept can be expressed namely, the partial and the total factor form. Total factor productivity is the ratio of total outputs to the sum of all contributing and associated resource inputs and so it pertains to how well an organisation uses all of its combined resources. In the partial form, productivity deals with each individual factor of production separately and its ratio relates outputs to one class of resource input.

However, the principal problem regarding the partial measures of productivity is that they only present a part of the whole picture, i.e. a company can be efficient and productive in the use of one of its resources but the productivity of the whole system can be low. Moreover, systems thinking would argue that because of synergy between resources and operating systems the ultimate output of a system is greater than the sum of the parts. Such arguments in fact indicate that partial measures of productivity cannot capture these synergy effects on productivity. In this vein, Brown and Hoover (1990) argued that a measurement technique that considers only one or few of the resources used to produce goods/services might result in limitations and potentially inaccurate productivity measurement.

There has been a tendency in the hospitality industry to adopt the partial factor approach to productivity due to the labour intensity of the industry. Nonetheless, Pickworth (1994) argued that the adoption of such a narrow perspective of productivity has constrained industry's approaches to productivity improvement. Industry has primarily focused on developing and improving programmes exhorting employees to work harder and smarter, which although they often increase employee productivity, they are usually difficult to sustain and have long-term dysfunctional effects. Moreover, by focusing on employees' productivity, the hospitality industry overlooks other resources of production.

In his effort to address the issues created by the partial and total factor approaches to productivity, Siegel (1986) defined productivity as a "family of ratios of output quantity to input quantity", which can be very large including different categories of output and input quantities. To that end, productivity is argued to be defined after a sum of metrics is produced and compared with each other. For instance, occupancy rates and Average Room Rates (ARR) give a measure of hotel rooms performance, but these combined with measures of rooms servicing costs can give a direct productivity measure for that part of the hotel's business.

Brown and Hoover (1990) also recognised that a total factor approach to productivity can be built up from multiple partial as well as aggregate measures and recommended the use of multiple partial measures of productivity for identifying the relationships and trade-offs among all the various resources used. For example, in a technological approach to back office automation systems, higher labour productivity may be achieved and will be represented by different partial measures of labour productivity. However, this may be at the expense of lower capital productivity as shown by capital measures. To that end, they (1990) provided several examples of a wide range of partial measures that are drawn from the hospitality and business literature and fall within the classification of labour, materials, energy and capital (Table 2.1.3.a). However, because of the difficulties arising when dealing with several metrics at the same time, Brown and Hoover (1990) advocated the prospect of combining partial measures in an aggregated composite index, which could in turn be weighted to reflect the relative importance of different partial measures.

Table 2.1.3.a Total factor productivity via multiple partial measures

Type of measurement	Examples of measurement
Labour ratios	Total output/labour expenses
	Meals produced/labour hours worked
Material ratios	Total outputs/material expenses
	Food cost/number of meals produced
Energy ratios	Total outputs/energy expenses
	Total outputs/British Thermal Units (BTUs) used
Capital ratios	Total outputs/capital expenses

Source: Brown and Hoover (1990)

Overall, there is no conclusive agreement as to: a) whether total factor productivity refers to the inclusion of all inputs and outputs rather than the consideration of each input at a time (partial measures); or b) whether the metric of total factor productivity refers to the measurement of both tangible as well as intangible features of the inputs/outputs regardless whether partial or total productivity ratios are calculated; or c) whether a total factor approach should consider other factors that may be external to the control of management but can crucially affect productivity, e.g. level of competition, location; or d) whether a total factor productivity approach should consider all the previous factors or a combination of them. Nevertheless, such conflicting productivity definitions clearly indicate and highlight the issues that should be taken into account when engaging in productivity research.

As well as debates around product versus service and partial versus total factor productivity, there are also issues regarding the relationship between productivity and the concepts of quality, effectiveness, performance and profitability. Each of these tends to derive from different theoretical perspectives. Quality derives from operations management, effectiveness is discussed in economic theory and performance and profitability are the concern of the business management disciplines.

2.1.4 Productivity and quality

A quantitative/economic approach to productivity assumes that the quality of output and inputs remains constant (Pickworth, 1994). Indeed, efficiency perspectives have traditionally underpinned the productivity practices of businesses. There have also been periods of time whereby quality and productivity were viewed as a trade off, that is to say that quality could only be achieved at greater costs. Examples are also found in the hospitality industry (e.g. Formule 1, fast food chains) where industrial engineers have shaped technological efficiency strategies related to plant, equipment and processes to increase productivity (Levitt, 1972; Filley, 1983).

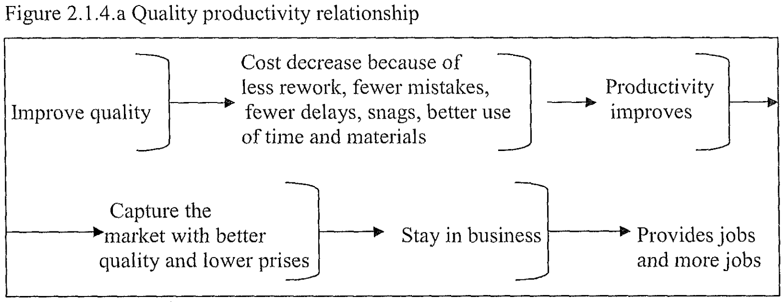
However, the sustained and exclusive reliance by any management upon the efficiency and quantitative criteria of productivity to the exclusion of other dimensions, such as dynamism and quality, has been questioned (Crandall and

Wooton, 1978; Thorpe, 1986; Pickworth, 1987). Specifically in the service industries, the economic approach to productivity has received a lot of criticism, mainly because of the intangible nature of their output. Moreover, because behavioural factors and quality issues are very influential in determining productivity levels and improvements, it has been argued that the conception of productivity should evolve to include quality factors. It is so clear that considerations of the intangible dimension of productivity are associated with the assertion that productivity should always be considered alongside those of quality. In other words, issues regarding the conceptualisation of productivity to incorporate quality dimensions are essentially related to the debate between the quantitative and total factor approach to productivity.

Indeed, arguments against too much concentration on quantitative measures of productivity are heavily articulated in both the general and the hospitality literature. Schermerhon (1989) criticised definitions focusing on the ratio of inputs and outputs, or, as he appropriately described it, the "traditional economic definition", because while they are used to achieve a good ratio they paid no concern of the human side of the process. However, from a manager's perspective, productivity reflects a broader performance measure as it defines success or failure in producing goods and services in quantity, of quality, and with a good use of resources. Thus, in his definition of productivity as *"...a summary measure of the quantity or quality of work performance with resource utilization considered",* Schermerhon (1989, p. 17) did raise the notion of quality. He (1989) also suggested that other things being equal, productivity rises in a work situation when the quantity of outputs increases, the quality of outputs increases, and the cost of resources utilized decreases.

Cascio (1992) also argued that "organisations must work smarter, not harder". The presence of the additional qualitative factors in both inputs and outputs in service operations is also recognised by Freshwater and Bragg (1975), who contended that traditional productivity computations have been unrealistic as they failed to take account of quality of resources, training and motivation. Deming's chain reaction also illustrates the relationship between productivity and quality (Figure 2.1.4.a). Leonard and Sasser (1982) found that efforts to raise quality almost always result in heightened productivity, while the converse is also found to be true, i.e. efforts to raise productivity usually pay off in better quality, but only if managers establish a new relationship between quality and costs.

Figure 2.1.4.a Quality productivity relationship



Source: Butterfield (1987)

In the hospitality literature, Pickworth (1987) attempted to rethink productivity and argued that the hospitality's concept of productivity should be broaden beyond solely economic concerns, since ignoring social inputs and outputs is not realistic as economic and social considerations are closely related, especially in the long-term. Specifically, Pickworth (1987) argued that productivity is inextricably linked with quality in a potent relationship based on innovation whereby each concept reinforces each other giving value to customers. Ignoring this positive synergy, managers can be faced with a downward spiral of negative effects. For example, productivity "gains" based on cost cutting can lead to a fall in quality standards, which in turn leads to a falling in sales; this is responded to by further cost cutting and a further loss of quality, with further loss of customers, until the business eventually ceases trading. Whatever the specific dynamics of the relationship, pursuing higher short-term productivity only at the expense of quality will inevitably lead to an experience of lower productivity in the long term. Thus, if dysfunctional outcomes are to be avoided, the two concepts have to be thought of simultaneously, i.e. any consideration of productivity must also include quality and (vice versa).

Ball (1996) also argued that a "trade off" between the quantity and quality of outputs in hotels may result in an adverse effect upon productivity. This is because any attempts to increase productivity in quantitative terms through efficiency-oriented productivity measures would be very likely to impinge upon the customer's perception of the service offered and might, if excessive, result in unmet customers' expectations and so customer dissatisfaction. Moreover, given the presence of customers on site and their involvement in the service process, Ball (1996) argued that the failure of a hotel to incorporate quality within its concept of productivity would be particularly short-sighted. For example, it might be possible to serve more customers in the front office or in the call centre with no increase in resources, but this may lead to less personal service and inadequate interaction between workers and customers.

Lockwood (1989) also provided an example of the productivity effect of quality. He (1989) argued that one of the strengths of Holiday Inn has been the consistency of the product and described how they have recently introduced a room guarantee to support their international reputation for room standards.

Prokopenko (1987) pointed out that both quality and quantity should be taken into account when considering the inputs and outputs, because although productivity may mean different things to different people, the basic concept is always the relationship between the quantity and quality of services produced and quantity and quality of resources used to produce them. He added that quality becomes a key issue when considering productivity in the hotel context, where the product is highly differentiated or customized. Unfortunately, as "quality" means different things to different people and "quality" of hotels is arbitrarily recognized through a number of national and international rating schemes, it is extremely difficult to measure.

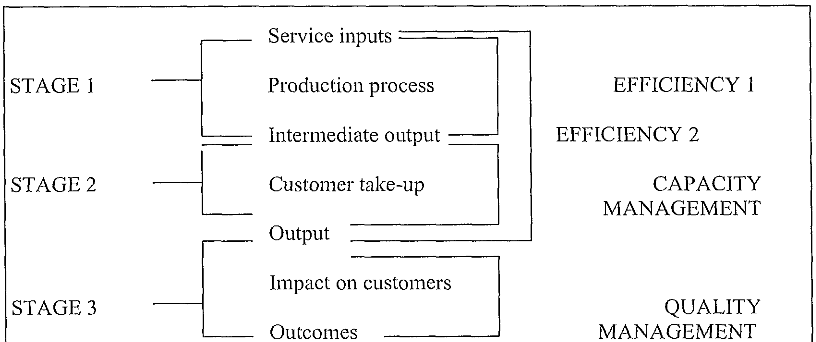
In developing a model for Total Quality Management in the hotel sector, namely the HOSTQUAL model, Christou and Sigala (2001) gave an extensive literature on the relationship between productivity and quality. When testing the HOSTQUAL model in a large sample of Greek hotels, Sigala and Christou (2001) provided empirical evidence of the positive relationship between total quality initiatives and hotel performance measured in enhanced revenue and market share and cost reduction.

It is generally agreed that marketing/sales in the service exchange process has a distinctive role (e.g. Cowell, 1984) and Rathmell (1974) summarised such arguments:

"Goods are produced, sold and consumed. Services are sold and then performed and consumed simultaneously... In place of the one interface between buyer and seller of goods – marketing – there are two interactions between the buyer and the seller of services – marketing and production"

In this vein, in their efforts to overcome difficulties because of the quality and intangible dimensions of service outputs, Jones (1988) re-classified "outputs" into intermediate (secondary) outputs, primary outputs and outcomes, which in turn had substantial effects on the definition of the productivity concept (Figure 2.1.4.b). Jones (1988) and Jones and Lockwood (1989) argued that all outputs of hospitality operations can be conceived as secondary or primary outputs, when a distinction is made between the process of input conversion/transformation and the sale or delivery to the customer.

Figure 2.1.4.b Model of service operations



Inputs: physical assets, such as plant and machinery and labour, which are combined in some way to create a series of intermediate outputs. **Intermediate output**: the capacity to provide the service. **Outputs:** the actual take-up of the service from the available capacity. **Outcomes:** the impact which the service may have on the customer

Source: Jones (1988)

For example, number of cleaned rooms is a secondary output, while metrics incorporating a "sales" element such as gross margin, average room rate, customers served, number of in-room amenities sold or occupancy rates are primary outputs. A catalogue of ratios can be compiled by fitting outputs to associated inputs, which may relate to different aspects of operating performance and to different organisational activities. So, productivity can relate either to the relationship between inputs and intermediate (secondary) outputs (Figure 2.1.4.b), i.e. Efficiency 1, e.g. the unit cost of making a service available, or to that between inputs and (primary) outputs, i.e. Efficiency 2, e.g. the cost of providing the service in relation to actual sales generated (Mill, 1988). The ratio between intermediate output to actual output was defined as capacity management, (Jones, 1988). The outcome factor in Figure 2.1.4.b is significant as the effectiveness of transforming outputs into desirable customer outcomes is a matter of quality. Jones (1988) argued that quality is an effectiveness issue ensuring the output is translated into desirable outcomes and that quality management involves the intangible and qualitative elements of inputs/outputs that can crucially affect sales and so productivity levels. Thus, according to Jones (1988) the concept of productivity is a composite of four concepts, i.e. efficiency 1, efficiency 2, capacity and quality management.

Mill (1989) also claimed that quality has to be married to quantity since productivity is linked with quality of output and input, and indeed, the process itself. In this vein, hospitality *"management will also have to make customer satisfaction, service and quality part of the productivity equation"*, while since quality judgements and expectations in hotels are influenced by external and environmental factors management need to recognise these as well (Mill, 1989, p. 12).

The importance of the totally of the factors argued by Mill (1992) is highlighted in Heap's (1992) concept of top-line productivity. Top-line productivity recognizes that "output" is an amalgam of a number of top–line factors and that productivity improvement is an exercise in optimising the mix of top-line factors for a given resource input (Heap, 1992). The rationale is that customers buy services made up of lots of different elements that contribute to its value (Witt and Muhlemann, 1994), as well as that since productivity is the key determinant of value, it is closely related to all the other factors that influence business value – quality, service, price and so on (Heap, 1996). Thus, top line productivity is not simply a strategy of increasing productivity by increasing outputs, but it also involves consideration of not only output levels but the totality of factors that are identified as components of output. In other words, top-line productivity is an attempt to consider more than one input (e.g. labour) to the productivity ratio, but more importantly, to recognize the importance of considering more than throughput in the numerator of the productivity ratio – the other top-line factors that may have a dramatic impact on the effectiveness of an organisation. For example, recognising that service for a hotel guest is his/her total experience, including not only what is done to him/her but also how it is done, the transformation process, the design of its procedures, working methods and its capabilities should all be considered in serving the guest.

Heap (1996) recommended that the "top-line" approach to productivity measurement should be adopted into hospitality and tourism from the manufacturing sector, but he did not demonstrate clearly how this might be achieved. Heap's top-line factors are representative more of a product than a service, but it might be possible to generate factors more specifically relevant to hotel productivity. However, Heap has been extremely creative in his attempt to embed quality issues in productivity measurement techniques and his contribution certainly highlights the importance of effectiveness and quality in positively influencing the productivity equation, however measured.

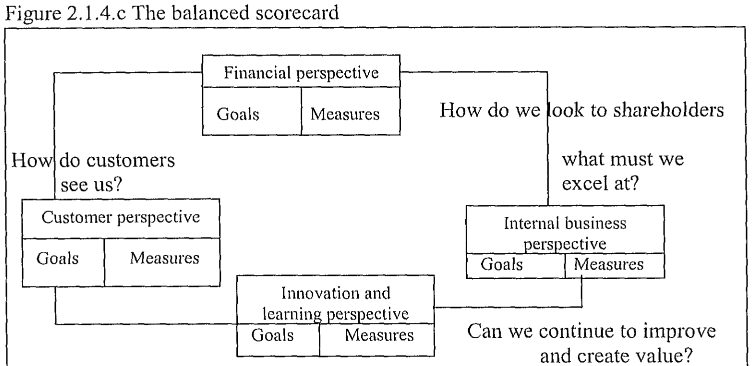
Heap's (1992) arguments for including top-line factors in the productivity concept are consistent with two performance frameworks namely the balanced scorecard (Kaplan and Norton, 1992) and the determinants and results matrix (Fitzgerald et al., 1996). Both frameworks distinguish between "results" of action taken and the "drivers" or "determinants" of future performance, as an attempt to address the "short-termism" criticism frequently levelled at financially focused metrics. In other words, the consideration of drivers/determinants is based on their significant impact on aggregate financial metrics. Thus, drivers/determinants/top-line factors are viewed as intermediate metrics whose impact is reflected on final financial metrics and so for management purposes in order to get final results the former should be considered and managed. So, Fitzgerald's et al (Table 2.1.4.a) framework proposes that measures of financial performance and competitiveness are the "results" of actions previously taken and reflect the success of the chosen strategy. The remaining four dimensions of quality, resource utilisation, flexibility and innovation are factors that determine competitive success, now and in the future. They represent the means or "determinants" of competitive success. The balanced scorecard (Figure 2.1.4.c) complements financial measures with operational measures on customer satisfaction, internal processes and the organisation's innovation and improvement activities that are the drivers of future financial performance. However, both frameworks are only prescriptive in the sense that the dimensions of performance are specified, e.g. customer perspective and quality, without providing any specific measures.

Table 2.1.4.a The results and determinants framework

	Dimensions of performance	Types of measure
RESULTS	Competitiveness	Relative market share and position Sales growth Measures of the customer base
	Financial	Profitability Liquidity Capital structure Market ratios
DETERMINANTS	Service quality	Reliability Responsiveness Aesthetics/appearance Cleanliness/tidiness Comfort Friendliness Communication Courtesy Competence Access Availability Security
	Flexibility	Volume flexibility Delivery speed flexibility Specification flexibility
	Resource utilisation	Productivity Efficiency
	Innovation	Performance of the innovation process Performance of individual innovations

Source: Fitzgerald and Moon (1996), p. 11

Figure 2.1.4.c The balanced scorecard



Source: Kaplan and Norton (1992)

Overall, it is evident that the top-line and/or quality approach to productivity definition argues the considerations of features that act as intermediate factors that result in the aggregate quantitative metrics of productivity. In this vein, such approaches to productivity are more analytical in terms that they incorporate the intermediate factors that need to be addressed in order to enhance productivity.

Arguments for the extension of the productivity concept to include quality issues are complemented by operationalisations of the concept that place quality measures alongside measures reflecting value of output and inputs. Johns and Wheeler (1991) proposed the inclusion of a quality dimension in the basic productivity formula (Figure 2.1.4.d), because "output" and "input" is not only a function of quantity or volume, but also of quality, since the value of what is produced depends upon both. According to this new formula, Steward and Johns (1991) identified three ways that productivity can be increased:

- by improving quality without a significant fall in output volume or increase in inputs;
- by improving volume without a significant fall in quality or inputs;
- by maintaining both volume and quality while achieving a significant reduction in inputs.

Figure 2.1.4.d The basic productivity equation re-expressed in order to include quality

$$\textbf{Productivity} = \frac{\text{Volume} \times \text{Quality (i.e. output)}}{\text{Volume} \times \text{Quality (i.e. input)}}$$

Source: Steward and Johns, 1991, p. 20

Ball (1996) advocated that since the output of hotels is entwined with the provider's efforts/input, the quality of the workforce, management and working conditions should be of an important consideration. In recognising the need to expand the basic definition of productivity so that specific reference is made to both the qualitative and quantitative dimensions, he (1996) proposed the following definition of productivity,

"...productivity is the relationship between the quantity and quality of goods and services produced and the quality and quantity of resources used to produce them"

He also alternatively expressed his definition in two formulas one referring to partial and the other to total factor productivity (Figure 2.1.4.e), indicating that the quality issue is relevant to both the partial and total approach to productivity:

Figure 2.1.4.e A quality extension to the basic productivity concept

$$\text{Partial productivity} = \frac{f\text{ (quality of outputs, quantity of outputs)}}{f\text{ (quality of inputs, quantity of inputs)}}$$

$$\text{Total productivity} = \frac{\text{total } f\text{ (quality of outputs, quantity of outputs)}}{\text{Quality and quantity of labour + capital + energy+ raw materials, etc}}$$

Source: Ball (1996)

Such conceptualisations and expressions of productivity are consistent with the economist's definition of productivity expressed arithmetically as in the following formula (Memahon, 1994, p. 66):

$$\text{Productivity} = \frac{\text{Wealth produced}}{\text{Resources consumed}}$$

Wealth is perceived as a function of both the quantity and quality of what is produced, i.e. Wealth generated = Quantity X Quality, indicating that when quantity and quality are increased, the wealth generated increases arithmetically in proportion. Thus, quantity, quality and resources all play a part in determining productivity.

2.1.5 Productivity, efficiency and effectiveness

The relationship between quality and productivity is highlighted in the operations management theory. In the economics literature, there has been an increasing debate about whether the concept of productivity should include or focus on efficiency, effectiveness or both. Mudie and Cottam (1992, in Johns, 1996) defined effectiveness and efficiency as:

"Effectiveness is the extent to which goals are achieved. The emphasis is on qualitative measurement and the objective is to meet customer's needs and to deliver service quality (doing the right things). Efficiency means a rate at which inputs are transformed into outputs. The emphasis is generally on quantitative measurement and the objective is to maximise output from the minimum input (doing things right)"

Simplified, effectiveness focuses on the output side of productivity, emphasising factors that can boost results, while efficiency focuses on the inputs side, emphasising the economic transformation of inputs into outputs. This is also illustrated in Jones' (1988) model of productivity whereby production operations were separated from marketing functions and four components of productivity were identified namely, efficiency 1 and 2, capacity and quality management. Thus, Jones' (1988) model provides an argument for including both efficiency and effectiveness in productivity measurement but it is also evident that since effectiveness entails quality focus and customer orientation, arguments regarding the relationship between quality and productivity (e.g. top-line factors, total factor productivity) also justify the inclusion of effectiveness in productivity conceptualisations.

Moreover, because of the great emphasis on the economic/quantitative approach to productivity, it can be assumed that productivity has been concerned with productive efficiency and capacity rather than effectiveness. Indeed, Rimmington and Clark (1996) alleged that the literature focuses too much on the efficiency aspect of productivity, i.e. controlling inputs while outputs are taken as given, and other goals and objectives of the organisation are overlooked. Thus, they (1996) and Ball et al (1986) emphasised that it is important to achieve both effectiveness and efficiency simultaneously by providing the following arguments.

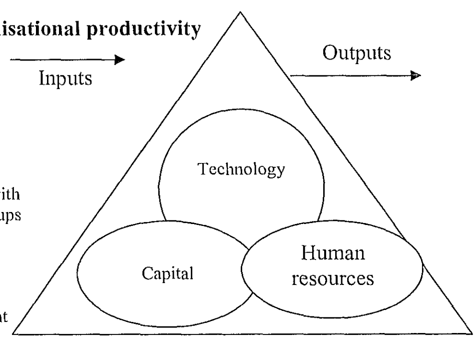
Specifically, Rimmington and Clark (1996) argued that productivity measures should encompass efficiency, effectiveness and quality because although the measures of effectiveness often concentrate only on one side of the productivity equation, the benefits of achieving enhanced productivity at higher levels of activity rather than lower are self-evident. For example, at the point of the highest resource efficiency rate, no more productivity improvements can be gained from better resource utilisation practices, but further productivity benefits can be achieved by innovative practices that affect the output side of the productivity equation, e.g. the provision of more and/or better services/products. This is consistent with the theory of performance frontiers, which support that performance benefits derive from two sources, i.e. efficiency gains from good utilisation of resources and effectiveness gains from the adoption and practice of good management practices.

On the other hand, the detrimental effects of over concentration on cost control at the expense of effectiveness (whether intended or brought about as a consequence of dysfunctional measures) are also highlighted. Even if cost containment is not the corporate culture it can become so either in times of recession when the cost control is necessary or through the incentive effect of measures that influence in a dysfunctional way. Because it is easier to control costs than to generate revenue, Watson (1994) pointed out that over-emphasis on bottom-line returns leads to denominator management because executives soon learn that reductions in investment and head count – the denominator – improve the financial actions by which they are measured more easily than growth in the numerator – revenues. However, managers who are quick to reduce investment and dismiss workers find that it takes much longer to regain lost skills and to catch up on investment when the industry turns up again.

Pickworth (1987) argued that because productivity should be considered as a multidisciplinary concept that focuses on optimising social and economic inputs and outputs, it should focus both on effectiveness and efficiency. Figure 2.1.5.a illustrates the hierarchy of components (effectiveness and efficiency) that contribute to his redefinition of productivity. Corporate productivity is the most important component within the hierarchy of productivity and relates to the effectiveness of corporate or organisational objectives, i.e. the productive strategic management of the organisation. Partial factor productivity is concerned with the effective use of each separate resource, while operational productivity with the efficient conversion of resources into products and services and embraces the traditional notion of productivity as efficiency. Employee productivity refers to the realisation of the potential productivity of the individual employee indicating how well an organisation is harnessing the abilities of its workforce.

Figure 2.1.5.a Components of organisational productivity

Hierarchy of organisational productivity



Productivity components

Corporate productivity
- identification of goals
- acquisition and deployment of resources
- optimal positioning of the organisation with regard to its environment and interest groups

Partial factor productivity
- effective use of finance
- effective use of personnel
- effective use of research and development
- effective use of marketing

Operational productivity
- efficient conversion of resources

Employee productivity
- realisation of full employee potential

Source: Watson (1996) adopted from Pickworth (1994)

In the same vein, Norman and Stoker (1991) also conceptualised productivity as a composite concept of the combined result of efficiency and effectiveness. Productivity or as they defined it "achieved efficiency" is a function of three factors namely effectiveness, economy and planned efficiency. The definitions and equations linking these concepts are provided in Figure 2.1.5.b. Inputs were conceptualised to cover both resources and factors that aid or hinder the achievement of the "actual outcome", (e.g. top-line factors etc), which again illustrates the link between arguments regarding the inclusion of effectiveness in productivity and arguments referring to the inclusion of quality in productivity. This is though not surprising since effectiveness is inextricably linked with quality considerations.

Figure 2.1.5.b Productivity as a composite concept of efficiency and effectiveness

Effectiveness: The attainment of pre-determined goals (outcomes or outputs)
Economy : Keeping within pre-determined cost targets (inputs)
Efficiency : The use made of resources in the attainment of outputs, in the context of environmental factors

Achieved efficiency = Effectiveness X Economy X Planned efficiency

OR

$$\frac{\text{Actual out come}}{\text{Actual inputs}} = \frac{\text{Actual outcome}}{\text{Planned outcome}} \times \frac{\text{Planned inputs}}{\text{Actual inputs}} \times \frac{\text{Planned outcome}}{\text{Planned inputs}}$$

Source: Norman and Stoker (1991)

Witt and Witt (1989) illustrated how quality and effectiveness issues can affect productivity and argued that both of these terms should be included and measured in productivity metrics. Schroeder (1985) also suggested the following productivity measurement formula:

Productivity = effectiveness × output/input

The strong relationship between these concepts is also argued by Brinkerhoff and Dressler (1990), who advocated that effective productivity measurement should meet four basic criteria:

a) quality (which differentiates a productivity measure from one simply concerned with efficiency);
b) mission and goals (which adds elements of organisation focus and hence effectiveness to the measure);
c) rewards and incentives (which relate measurement to individual performance and help make it a sustainable (i.e. monitoring) activity;
d) employee involvement (which permits shared ownership of productivity measurement, encourages acceptance by the workforce, and hence facilitates sustainability).

As the definition of productivity should include effectiveness, Pickworth (1987) suggested that satisfied customers rather than the number of meals should be regarded as outputs. Brinkerhoff and Dressler (1990) suggested that ratios emphasising customer satisfaction or the achievement of corporate goals are measures of effectiveness and contrasted them with measures emphasising output at the expense of quality, which they considered really to be concerned with efficiency. In these terms, they regarded "true productivity" as the ratio of added value (of output) to input.

2.1.6 Productivity, performance and benchmarking

The concept of productivity, efficiency and effectiveness are mainly found in economic theory, while in business management the concept of performance "benchmarking", which is based on the notion of comparing different production units, has received a lot of attention (Andersson, 1996). Basic to any performance analysis is the definition of output variables and input variables of a production unit and it is by this way that performance is related to productivity. Particularly, Andersson (1996) argued that as with productivity definition and measurement, the concept of performance varies depending on the variables and the measurement units that it encompasses. In this vein, Heap (1992, p. 18) argued that:

"Traditionally, performance has been associated with efficiency and has been used as a "low-level" indicator to assess how "hard" a person, machine or department has been working. Performance measures are thus comparable to productivity measures in that they relate an output to the inputs used to achieve that output. Generally, effectiveness has not been incorporated into measures of performance. In fact, one of the great dangers of productivity and performance measures is that there may be a tendency to concentrate on factors which are easily and directly measurable rather than those that have a major contribution to organisational effectiveness"

In other words, when performance variables and their measurement reflect similar concepts to productivity, then the productivity and performance can be used interchangeably. So, for example, by performing a study on the performance indicators or measures that hotel executives deemed most important, Geller (1998a,b) found the following productivity related metrics: occupancy percentage, average room rate (ARR), gross operating profit, rooms-department sales and rooms department profit.

However, the relationship between performance and productivity is more clearly illustrated in the concept of a performance benchmark. The basic idea of the performance "benchmark" approach is to set a standard, that a production unit should strive for and according to Andersson (1996), it is this performance benchmark that introduces an active approach to productivity assessments. However, Camp (1989) and Parsons (1994) argued that the comparison of various productivity measures is only part of benchmarking and that the development and implementation of action plans aiming at closing the "performance gap" are also required. Wober (2001) implicitly demonstrated the link between performance benchmark and broadly conceptualised productivity (that includes quality and effectiveness issues) by arguing that benchmarking is being positioned as being an extension of an existing total quality programme and as being a way in which to establish new, more relevant efficient standards of performance. Therefore, there are arguments that a broader general definition and measurement of performance benchmark should include "top-line" or "upstream" intangible factors and issues that can ensure long term improvements, just as in the productivity literature.

There are a number of definitions of benchmarking (e.g. Bendell et al, 1993, p. 54; Karlof and Ostblom, 1993, p. 9; Peters, 1994, p.20). However, the one provided by the International Benchmarking Clearinghouse (IBC) Design Steering Committee of the American Productivity and Quality Center (APQC) is given here as it represents a "*consensus among 100 companies*", (Watson, 1993, p.3):

"Benchmarking is a systematic and continuous measurement process; a process of continuously measuring and comparing an organisation's business processes against business process leaders anywhere in the world to gain information which will help the organisation take action to improve its performance"

(Watson, 1993, p.3)

exploitation is related to performance). Environmental (e.g. business variability) and business (e.g. ownership type) factors have also been considered in order to be able to generalise results.

Considering the tourism and hospitality sectors, the majority of benchmarking studies are found in the accommodation sector. For example, benchmarking was argued and used for hotel quality management and measurement purposes [Christou and Sigala (2001) and Sigala and Christou (2001), Min and Min (1996), Motwani et al (1996), Breiter and Kline (1995)], while Boger et al (1999) used benchmarking for comparing discounting practices in hotels. Phillips (1999) and Phillips and Moutinho (1998) proposed and tested a managerial tool called the strategic (marketing) planning index, which measures the effectiveness of strategic planning (marketing) activities and facilitates the benchmarking process. However, although benchmarking activity is growing in large organisations (e.g. Horwath International, 1998; Pannell Kerr Forster, 1998), it has had limited use amongst small hospitality firms (e.g. Bottomley, 1995; Sundgaard et al, 1998). In interviewing 25 senior small and medium enterprises (SME) managers in their current use and perceived or actual barriers to benchmarking, Monkhouse (1995) concluded that the practice of benchmarking is embryonic in SME and that a range of tools and techniques capable of accommodating the idiosyncrasies of SME need to be developed and made accessible. On the contrary, Kozak and Rimmington (1998) found that examples of benchmarking carried out amongst SME have already been carried out by external third parties, but the latter first benefit from the data before providing the information back to the industry.

2.1.7 Productivity and profitability

It has also been argued that certain accounting ratios which assess profitability also measure productivity. Johns and Wheeler (1991) found that two profitability ratios, namely gross profit ratio and net margin ratio (Figure 2.1.7.a illustrates their calculations), are often used and calculated monthly or even weekly and are highly regarded in the industry as control indicators. In particular, Johns and Wheeler (1991) argued that the gross profit ratio is useful as a measure of operating efficiency, as it ensures that the business is earning sufficient revenue from trading to cover wages and other costs and to leave an adequate profit. Return on capital employed (ROCE) is also regarded as a measure of productivity from the shareholder's or owner's point of view, i.e. the rate of return on capital outlay.

Figure 2.1.7.a Calculations of gross profit and net margin ratio

$$\text{Gross profit ratio} = \frac{\text{Gross profit}}{\text{Sales}} \times 100$$

$$\text{Net margin ratio} = \frac{\text{Net margin}}{\text{Sales}} \times 100$$

Net margin = gross profit - wages – staff costs

Source: Johns and Wheeler (1991)

A number of benchmarking types are known depending on whether the benchmark is within the company (internal benchmark, e.g. benchmark of units within an hotel chain), within an industry, the same function in another industry, or even another function in another industry (external benchmark), (Bendell et al, 1993, p. 69). The present study is concerned with external benchmarking, as it is based on comparing empirical data gathered from a whole sector, i.e. the three star hotel sector.

As regards the subjects of benchmarking, although many aspects of the organisation can be benchmarked, the tangible and intangible features of the firm's product have been traditionally considered as a straightforward benchmarking (Peters, 1994, p. 22). Attention has though moved into benchmarking organisational elements, e.g. culture, people, financial performance and customer satisfaction indices (Neergaard et al, 1997, p. 27). However, there is a consensus in the literature that benchmarking these features per se is not a very fruitful approach, e.g. Bendell et al (1993, p. 6) argued:

"These measures are fundamentally of output performance, they show how much or how little is being achieved by the organisation in comparison to competitors and to the world's best practice. They do not show the weaknesses in the internal business processes or strengths. They do not show how the competitors and world leaders are achieving what they are. They do not show what, if anything is transferable to the organisation's particular circumstance and how to make the transfer".

Thus, according to Watson (1993, p. 6) "*although benchmarking is a measurement process and results in comparative performance measures, it must also describe how exceptional performance is attained*". To that end, the focus of benchmarking or best practice should be on how and why performance is achieved, i.e. *who is best?* and *what makes them so successful?*. Indeed, Watson (1993, p. 6) argued that such a benchmarking process should have two types of outputs, the enablers representing the theory behind the process performance and the benchmarks or measures of comparative performance. Neergaard et al (1997) advocated and included environmental and business variables in order to investigate the transferability or generability of their identified best practices. Wober (2001) also argued that benchmarking partners should also match on levels of service provided, difficulty of operating environments etc, because practices that are efficient and effective in one environment may not be relevant or helpful in a different environment. Wober (2001) also identified the problems inhibiting the development of systematic research in the area of performance benchmarking as follows:

- benchmarking is a new phenomenon that only gained widespread attention in the early 1990s;
- as benchmarking is a practitioner-generated concept, it is loosely defined, and measures and tests for studying it need to be developed;
- benchmarking involves aspects of a firm's operations and many firms are reluctant to allow access to independent researchers.

In this vein, this study aims at meeting two objectives. With specific reference to ICT, the identifications of the factors and metrics that determine comparative performance (i.e. the identification of which hotels and on which factors are the best, through the application of a stepwise DEA) and secondly, the investigation on how high performance is achieved (i.e. by controlling the effect of several factors on performance, e.g. business variability, market segment mix etc, investigate how ICT

However, like other accounting ratios, these highly generalised revenue-oriented ratios only offer a very aggregated estimate of productivity. They cannot in general be used to monitor operational productivity, to identify the factors that lead to high or improved performance and so in turn, motivate middle management in this respect.

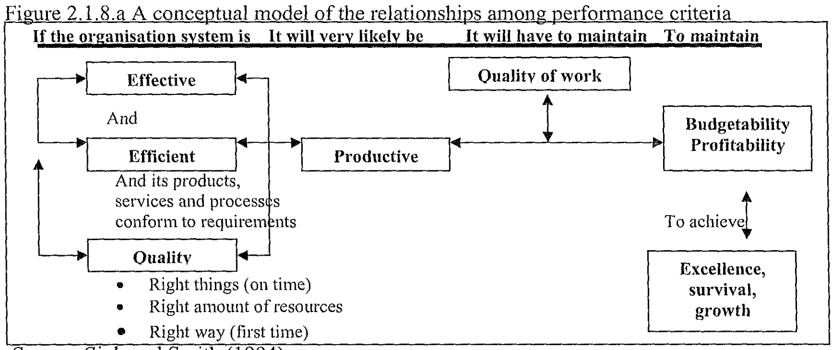
Heap (1992) argued that profitability only gives a distorted view of business efficiency, because profitability ratios are subject to localised and temporary price and currency fluctuations and to the forces of supply and demand. For example, increases in price may raise profitability in the short term, but they will only reflect an actual increase in productivity when the market has stabilised and the price truly reflects demand. Moreover, the capital cost of land and fixed assets is likely to be much higher in an inner city area, and this will distort attempts to qualify the true productivity of hospitality units. Non-profit organisations by definition cannot use profitability as a surrogate for productivity.

Overall, profitability offers an alternative of measuring the well being of an organisation but although important it is often a short-term indicator and so can easily be influenced by several factors. Thus, profitability ratios may be used as aggregate metrics of productivity, but for productivity benchmarking and improvement purposes they should be used in conjunction with other more detailed metrics.

2.1.8 A new approach integrating the productivity dimensions

After conducting a literature review, Sink and Smith (1994) argued that there are at least seven interrelated and interdependent performance criteria for an organisational system: effectiveness, efficiency, productivity, quality, quality of work life, innovation and profitability (profit centre) or budgetability (cost centre). They argued that the seven criteria are substantially inclusive but not necessarily mutually exclusive and that an intervention to improve the performance of one entity may be expected to improve one or more of the others. The interrelationships between these are illustrated as in Figure 2.1.8.a.

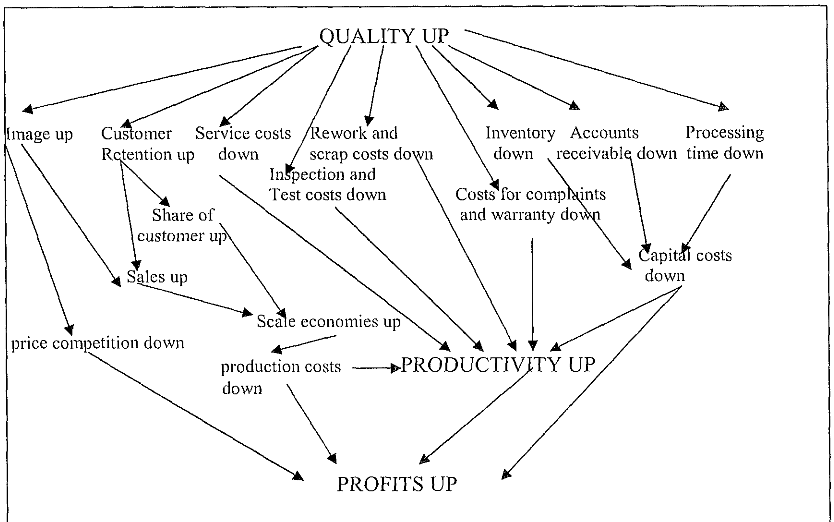
Figure 2.1.8.a A conceptual model of the relationships among performance criteria



Source: Sink and Smith (1994)

A more detailed analysis of the interconnections between the productivity dimensions was conceptualised and illustrated by Gummesson (1998). He (1998) advocated a new approach to performance, i.e. "the triples at play" (Figure 2.1.8.b), which like Jones' (1988) model, aimed at integrating productivity dimensions. According to Gummesson (1998) quality, productivity and profitability are triples (separation of one from another will create an unhappy family) that serve the purpose of making service operations efficient. He also represented profitability by relationship marketing (RM), which stresses loyalty, customer retention and long-term relationships as keys to profitability. Relationships between service providers and customers significantly stand out in the service encounters and production processes.

Figure 2.1.8.b The triples at play



Productivity: the ratio between output and input; most commonly used for reduction of cost and capital employed; tradition from engineering and manufacturing (Fordism, Taylorism and work study).

Quality: Previous emphasis on technical aspects, quality as perceived by design and manufacturing specialists; today emphasis on quality as perceived by the "user specialists", the customers and expressed as customer satisfaction, value to the customer, and revenue; service quality has developed from services marketing into a unique discipline.

Profitability: Traditionally, the combined effect of revenue, cost and capital employed; increasingly a relationship marketing and customer retention approach; a broadening of indicators from merely financial indicators to the balanced scorecard and intellectual capital.

Source: Gummesson (1998)

The figure starts with quality, defined as doing things right from the beginning and doings things that customers need and want. Quality improvements can result in a positive impact on revenue (left section of the figure), cost (middle section) and capital employed (right section). When function and reliability improve, they boost the image in the market, customer retention and share. These changes boost sales, differentiate a provider from the competition and make the provider less dependent on price competition. Service costs for machinery go down, and so do the costs of inspection, testing, rework, scrap, complaints, and warranties. The capital employed is reduced as less stock needs to be kept; accounts receivable go down because payment comes earlier and less payment is delayed because of complaints; and reduced processing time requires fewer resources. As the cash flow becomes faster, the money can be used elsewhere and capital costs are reduced. Improved productivity becomes an antecedent to profitability and some factors directly affect profitability through enhanced revenue.

It is so clear that the triples are related to financial factors, which constitute the result of a company: cost, revenue and capital employed. Thus, metrics of end results should reflect and incorporate the intermediate effects described in the previous figure (Gummesson, 1998). This entails that ratios of aggregate final input/output metrics refer to a productivity conceptualisation that incorporates the effect of all issues, i.e. quality, effectiveness, efficiency and profitability. These ratios though are not able to distinguish the effect of each issue on productivity improvements or differences.

However, Gummesson (1998) argued that current management theory and practices are not sufficiently sensitive to the customers' role in services as well as to the management and measurement of soft/intangible, i.e. the "upstream" or "top line factors", that can substantially affect productivity levels. He then proposed four novel approaches in the management area that are significantly able to affect organisations' performance because as he illustrated they are closely related with the triples. These are: relationship marketing; imaginary organisations; the balanced scorecard approach to accounting and management; and intellectual capital. The importance of these managerial practices in performance becomes more crucial when considering the constructive role of ICT in fostering and supporting such managerial practices. The ICT role will be analysed in the following sections. Nonetheless, although Gummesson (1998) explained how these four new approaches can significantly influence the triples, he did not provide any suggestions on how these factors should be measured.

2.2 Productivity measurement

2.2.1 Introduction: purpose and difficulties of productivity measurement

In practice, various different measurements have been used to investigate productivity in the working environment and this has led to disagreement and confusion over the concept of productivity (Mahoney, 1988). On the other hand, confusion and disagreement over the concept/definition of productivity has also created difficulties in productivity measurement. Thus, some measurements relate to efficiency of performance (e.g. return on investment, cost per unit, output per employee); other measurements relate to outcomes (e.g. sales, customer satisfaction, profits). Efficiency measures can show whether an organization is doing things in the right way, but do not indicate whether the organization is doing the right things, effectiveness, (Thorpe and Horsburgh, 1991). The types of measurement that are most appropriate depend on the purpose for which they are to be used.

Teague and Eilon (1973) identified four purposes/reasons for productivity measurement. It can be used for strategic purposes, i.e. as a basis for taking longer-term comparisons with competitors. Productivity measurement can also be used tactically, i.e. for controlling specific functions of an organization in order to enhance overall performance. Thirdly, productivity measurement can be used for planning purposes, as it allows management to balance and compare the different yields from a range of outputs. And finally, productivity measurement can be used for other purposes, e.g. collective bargaining or staff motivation. Hopwood (1976), Anthony et al (1992) and Umbreit et al (1987) have drawn attention to the fact that information and control/measurement systems are not neutral, but in themselves shape and affect behaviour through the signals that they give. As Drucker (1973) states it is the specific productivity objectives that are essential to give a business direction, while without productivity measurement there is no control. In the same vein, Kaplan and Norton (1992) argued that:

"what you measure is what you get. Senior executives understand that their organisation's measurement system strongly affects the behaviour of managers and employees"

The present study aimed at investigating the productivity effect of ICT by comparing productivity differences among three star hotels that had different ICT configurations. Therefore, research findings are argued to be of a strategic and operational value as well as helpful for personnel evaluation and motivation purposes. Provided that the business value of specific ICT projects will be identified and justified, hotels can use results for developing their strategic plans. Moreover, the study identifies the particular uses and configuration of ICT systems that are required for successful operational implementation of strategic ICT investment plans as well as giving staff the direction and motivation on how ICT should be best applied.

The difficulties in measuring productivity are threefold (Fitzimmons and Fitzimmons, 1998; Andersson, 1996): a) what are the appropriate inputs and outputs of the system? b) what are the appropriate measures of those inputs and outputs? and c) what are the appropriate ways of measuring the relationship between inputs and outputs?

Productivity measurement in the hospitality industry in particular faces additional difficulties due to the specific characteristics of its service nature (Lee, 1991) that in turn create problems such as the variability of labour requirements, consistency, demand and throughput (Witt and Witt, 1989). Subsequently, Witt and Witt (1989) identified the following three problems regarding productivity measurement in hospitality that are compatible to those three previously mentioned productivity difficulties identified in the general literature. The first two difficulties are pointed out by Fletcher and Snee (1985) as the "definition problem" and the "measurement problem", which apply particularly in the service sector. The third problem is referred to as the *ceteris paribus* problem.

Fletcher and Snee (1989) described the definition problem as those difficulties encountered when attempting to define precisely what is the output of a given industry. This is particularly difficult when the "product" or output is intangible or has large elements of intangibility as is the case in most service industries (Packer, 1983). Meredith (1989) illustrated the problem by giving an example, which also demonstrates that the definition problem is similar to the problem of identifying the right inputs and outputs. So, "if arrests per police officer go down in one year compared to the year before, has police protection improved because of prevention or worsened because, perhaps, of a slackening in apprehension efforts?"

The measurement problem was described as the problem encountered when output can be defined but cannot be measured (Fletcher and Snee, 1989). However, Fletcher and Snee (1989) advocated that the distinction between the definition and measurement problem most times is far from clear, since a firm's output that is easily definable is very often easily measurable. Moreover, even if a firm's output can be measured in some way, there may be problems in terms of using suitable units of measurement, as it should be ensured that like is being compared with like. Similarly, there may be difficulties with measuring inputs, as for example, two part-time employees are equated to one full-time equivalent, but which clearly may not be the case. Hence, the "measurement problem" is similar to the problem of identifying the right measurement units of inputs and outputs.

The *ceteris paribus* problem involves holding the other influences constant when examining the impact of a particular factor on productivity. Productivity in hotels may be said to be a function of several factors both internal/controllable (e.g. such as type of hotel, class of hotel, range of services offered, relative mix of services offered, training wages paid, expertise of the management, volume of trade) and external/uncontrollable (e.g. general education levels, the efficiency of the transport system providing access at work, competition, gross national income) to the hotel. Thus, comparisons of productivity ratios can be misleading unless "other factors" are held constant. To some extent, the way that inputs and outputs are related/compared (i.e. the third difficulty) can address the *ceteris paribus* problem, bearing though in mind that it is hardly possible to incorporate all factors affecting productivity in one metric. Therefore, careful interpretations of productivity metrics are required.

Overall, the International Labour Organisation, as quoted by the National Economic Development Council (NEDC, 1992, p. 29), noted:

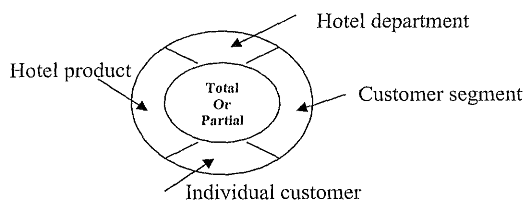
"Although productivity can be reduced to a neat equation (output divided by input), its measurement is much more difficult to deal with. At the national, sectoral or enterprise levels, it rapidly becomes clear that there is no single "true" measurement of productivity; rather it is the reflection of a family of ratios, of percentages, of approximations and in some cases, of "proxies" (i.e. values that are indicators of what the productivity might be".

However, in itself this statement is quite unhelpful. In effect it means that management must decide for themselves the most suitable ratios for monitoring productivity and then negotiate these with their workforce in order to generate the kind of "productivity culture" (Heap, 1992).

2.2.2 Identifying/selecting inputs and outputs

The selection of items to be covered by output and input variables is a first step in measuring productivity. A general rule of thumb is to include in the input variable only such items that can influence the output variables. To that end, the unit of analysis (e.g. production system, the process, the resource(s) etc.) whose productivity

Figure 2.2.2.a Types of productivity ratios



2.2.2.1 Input/output selection in total and partial productivity approach

One of the two interpretations of the total versus partial approaches to productivity involved the consideration of whether one includes all or only some input factors. Adam and Ebert (1986) break down costs into labour, capital, materials and energy. Thus, a total approach to productivity measured at the organisational level considers all inputs and so all of them will be included in the ratio:

$$\text{Productivity} = \frac{\text{Sales revenue}}{\text{Labour} + \text{Materials} + \text{Overheads} + \text{Energy}}$$

On the other hand, when partial productivity ratios are calculated for each input then only the relevant input will be included (Johns and Wheeler, 1991):

$$\text{Material productivity} = \frac{\text{Sales revenue}}{\text{Material cost}},$$

$$\text{Labour productivity} = \frac{\text{Sales revenue}}{\text{Direct labour costs}} \quad \text{and etc.}$$

The service sector and the hospitality industry more specifically have concentrated particularly upon partial measures which link output to the labour input, i.e. labour productivity (e.g. Pine and Ball, 1987; Jones and Lockwood, 1989; Mill, 1989). The focus on labour productivity is mainly due to the high labour intensiveness of the hospitality industry. Ball et al (1986) argued that labour is a legitimate focal point for hotel managers managing productivity, because labour is present in almost all output-generating endeavours and represents a significant proportion of hotel costs. Another reason for focusing upon the labour input in productivity in the hospitality industry is that labour measurements (e.g. hours worked) are normally readily available through electronic point of sales systems, rotas and clock-in clock-out machines (Ball, 1996).

However, labour is only one input and comparing the value of output only to the value of labour ignores the relative efficiency with which all the other resources within the operation are used. Blois (1984), for instance, regarded labour productivity as unsatisfactory as output production is normally the consequence of a combination of needs to be measured is necessary in order to identify the inputs and outputs that will have to be taken into consideration.

Jones (1990) advocated that productivity boundaries should be considered and made a significant contribution by identifying three levels of productivity measurement. Specifically, the unit of productivity measurement can be at the individual, group and organisation-wide level. Jones' approach considers different aggregates of employees within the organisation in order to ensure that productivity is given a high profile throughout the organisation. The unit of analysis needs to be defined in order to correspond inputs with outputs at the same level of analysis, e.g. employee hours at the individual level will be related with output value at the individual level. For example, Table 2.2.2.a illustrates how labour cost measures can be related to revenue at different levels within the organisation. Jones (1990) argued that such measurement has become feasible due to the utilisation of electronic point-of-sale (EPOS) technology, linked to computer based Management Information Systems (MIS).

Table 2.2.2.a Intra-organisational productivity measurement perspectives

Measure	**Overall organisation**	**Restaurant department**	**Individual food service worker**
Labour cost % revenue			
Labour cost per labour hour			

Source: Jones (1990)

Moreover, the identification of the inputs/outputs that should be taken into consideration also depends on whether a partial or a total approach to productivity definition is taken. In other words, the question is whether one, more or all input/outputs and/or whether other internal/external factors affecting productivity will be considered depending on how the partial and total approach to productivity definition is interpreted.

It is practically impossible to develop a metric that could take into consideration all these factors and even if it is, it would be impossible to interpret its results and give sound advice for productivity improvements actions. Thus, the selection of the variables to be included in a productivity ratio should mainly depend on the purposes for which productivity is being measured. This study aims at measuring productivity in order to investigate the productivity effect of ICT by correlating productivity differences with different ICT configurations within the three star hotel sector. Hence, inputs and outputs on which ICT could have a logical and direct impact as well as factors that could have affected such relationship, e.g. different ICT use, business variability and ownership type were measured and included in this study.

Overall, the selection of inputs and outputs requires the determination of two things (Figure 2.2.2.a): a) the approach to productivity definition, i.e. total or partial approach and b) the identification of the level/unit of analysis. Thus, productivity ratios are calculated by aggregated input/output metrics reflecting total or partial approaches to productivity. Aggregated input/output metrics can in turn be disaggregated at any level/unit of analysis (such as by hotel department, product, segment or individual customer) in order to construct a whole "family"/ "hierarchy" of productivity ratios.

input factors. In the same vein, Hall (1973) criticized the use of labour inputs in productivity measures as it implies, quite incorrectly, that all productivity gains are the result of labour's effort. In fact, criticism is frequently levelled at partial productivity ratios, in that they tend to consider only one input and output at a time. For example, in his study, Andersson (1996) found no significant correlation between labour and capital productivity ratios irrespective of their measurement units concluding that different partial measures give different assessments of productivity.

Thus, there has been growing promotion of the use of broader-based productivity measurements to include such elements as capital, materials and energy as well as labour. Chew (1986) argued the importance of a multi-factor view of productivity but highlighted the difficulty for one index to encompass all inputs. He proposed the simultaneously use of several different single-factor measures, which though can be difficult to handle and interpret. Several authors (e.g. Andersson, 1996; Johns et al; 1998) have argued the powerfulness of the DEA technique for dealing with multiple inputs and outputs at the same time. However, according to Andersson (1996) the choice of output as well as input variables is only in rare cases able to include all relevant aspects of resources used and created. Whether they are relevant or not must be assessed from case to case and always in relation to the purpose of the analysis being carried out. Thus, this study uses the DEA methodology in order to overcome the difficulties in dealing with multiple inputs/outputs simultaneously, while inputs/outputs to be included in the productivity ratio are being identified and justified by a stepwise approach to DEA.

Total and partial ratios may also be reversed, e.g. wage cost/sales revenue rather than sales revenue/wage cost, in order to emphasise costs over revenue or revenue over costs respectively. Revenue related ratios are for example occupancy percentage, average spend and sales revenue per employee. Ratios emphasising costs include rooms' wages to rooms' sales, material costs as percentage of F&B sales and administration costs as a percentage of total sales. The particular emphasis of the ratios used reflects the organisational culture and management attitudes and approaches to productivity management and improvement, which in turn filters down through the system and affects the motivation of the staff (Johns and Edwards, 1994).

When the total factor approach to productivity is interpreted that productivity also includes factors affecting it, then productivity ratios should be changed to reflect that. In this vein, Heap (1992) developed the concept of the top-line productivity that includes factors classified into three categories namely functionality, reliability and aesthetics but he did not provide any example of their measurement. Other quality or external (e.g. competition, level of demand) factors can also be included into productivity ratios, but because of the difficulties regarding their measurement and inclusion in productivity metrics, productivity ratios tend to measure what it is possible rather what it should. For example, by using the DEA methodology, Banker and Morey (1986) illustrated the impact of inputs uncontrollable by the individual restaurant manager (age of store, advertising level, location and drive-in capacity) on fast food restaurant productivity. In other words, most often a quantitative rather than a qualitative approach to productivity is followed. A more detailed analysis of how quality can be measured will be provided in the section entitled "selecting measurement units of inputs/outputs".

2.2.2.2 Input/output selection at different level/unit of analysis

It is also possible to break down productivity metrics at different and varied levels. This is often required because metrics at aggregate levels cannot provide a fruitful insight as well as explain productivity differences and improvements. Several authors argue that much more information will be gained when inputs and outputs are analysed by department. In this case, the productivity ratio at the organisational level includes the following inputs/outputs:

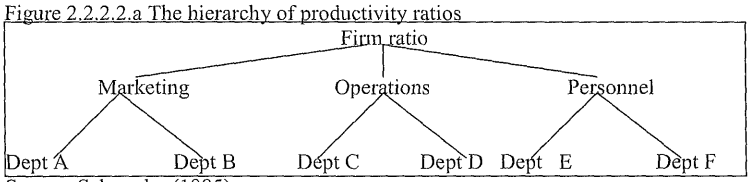
$$\text{Productivity} = \frac{SR_1 + SR_2 + SR_3 + \ldots}{Costs_1 + Costs_2 + Costs_3 + \ldots}$$

Where: SR_1, SR_2 , SR_3, etc are the individual departmental sales revenues
$Costs_1$, $Costs_2$, $Costs_3$ etc, are the individual departmental costs

Productivity ratios for each department include inputs/outputs found only at the departmental level. All departmental productivity ratios consist of the family of ratios that build up the productivity at the organisational level, which in turn means that productivity at the organisational level is affected by each departmental productivity ratio.

Schroeder (1985) illustrated the hierarchy of productivity ratios within a firm as in Figure 2.2.2.2.a that also illustrates how partial productivity ratios link with each other:

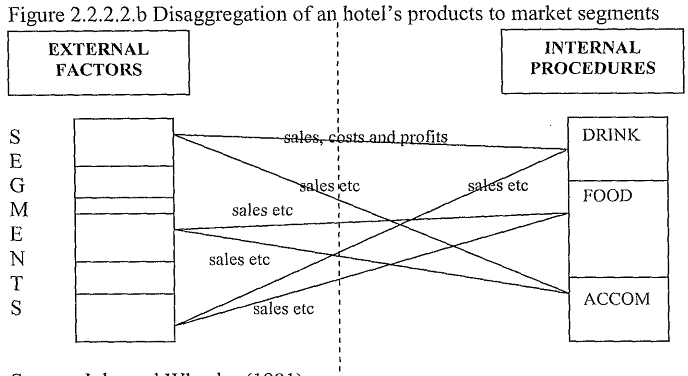
Figure 2.2.2.2.a The hierarchy of productivity ratios



Source: Schroeder (1985)

Another way of analysing productivity information is to break it down by product. In this case the items SR_1 / $Costs_1$ etc refer to items sold, while a spectrum of high to low price classification can be used, i.e. SR_1, SR_2 , SR_3, etc. Johns and Wheeler (1991) also illustrated how such disaggregation can be achieved for both departments (right hand side) and market segments (left hand side), Figure 2.2.2.2.b. Indeed, as Ball et al (1986) stated productivity ratios can be identified for any feature of hotel operation once the inputs and outputs have been identified.

Figure 2.2.2.2.b Disaggregation of an hotel's products to market segments



Source: Johns ad Wheeler (1991)

Recognising the disadvantages of using partial measures of productivity, as they tend to hide useful information on performance of other departments, Brown and Dev (1999) proposed that productivity measures should be modified from product-oriented measures to customer-oriented measures. In this vein, they proposed the measurement of productivity at an even lower level of analysis, i.e. disaggregate inputs/outputs at the individual customer level by also providing examples of hotel and non-hotel companies that already use such metrics. For example, Holiday Inn, uses unconventional measures of productivity such as revenue per available customer (RevPAC) while Federal Express and US West are examining profit per available customer (ProfitPAC) in order to provide insight into ways to boost their market impact. Food service and retail businesses usually use another customer-oriented measure namely "share of wallet", that measures the extent to which the business has tapped the purchasing potential of the customer. The measurement of such metrics requires the measurement of several items that are not included in the room rate, e.g. rooms revenue, on-premise or take-out food and beverage purchases, gift shop sales and other products/services. The shift and emphasis on such metrics as well as the gathering of relevant data has become crucially important with the widely and sophisticated application of ICT e.g. customer databases, customer loyalty schemes etc, that aim to boost productivity by identifying, building and maintaining relationships with the most profitable customers. Brown and Dev (1999) argued that productivity measures reflecting customers' actual purchasing habits over time are more valuable than calculations that merely consider a hotel's physical assets or the size of its own work force. However, apart from some exceptions, the adoption of RevPAC and ProfitPAC in the hotel industry is very limited (Brown and Dev, 1999).

Libert and Cline (1996) also argued the use of RevPAC as a crucial productivity measure for hotels in the new information era. Specifically, they (1996) argued that *"you are what you measure, and you measure what you think is important"*, which in turn means that the ways in which organisations gauge performance reflect their historic roots and basic orientation to creating values. In this vein, RevPAR (the hotel industry's worldwide standard metric) is more than a simple way of quantifying results, because it reflects the industry's fundamental structure and value proposition based on physical assets (hotel rooms) as the driver of wealth. However, Libert and

Clein (1996) also argued that as technology changes the way hotels serve customers, hotels should change the way they measure themselves. Technology enables hotels to serve customers in both physical place (rooms) and virtual place, i.e. anywhere at anytime, and so, the most profitable hotels will be those that capture an increasing share of the customers' purchasing power – while they are in the hotel, at home or anywhere else in the world. As customers become a fundamental driver of value in the hospitality industry, so the metric RevPAC becomes a more appropriate measure for hotel performance. The latter embodies a shift in perspective from an "asset play" based on rooms and properties to a focus on leveraging customer equity (Libert and Cline, 1996). However, as Libert and Cline (1996) argued an integrated ICT hotel infrastructure is required in order to support industry's potential for improving customer equity. For example, integration of reservation systems and customer information in a total system solution that provides data warehouses and network communications can provide a crucial platform for highly focused marketing and product development strategies.

Johns and Wheeler (1991) also argued that the disaggregation of accounting data, (of both sales and costs), into market segments, according to the "hotel's portfolio", provides more useful information and gives a more market-oriented approach to productivity than traditional accounting systems. This is because the latter are based on food, drink and accommodation, i.e. department oriented, designed to emphasise responsibility and controllability and short term results. On the other hand, output measures should be directed towards the customer and the marketplace. In this way, productivity measurement is more compatible with proactive management rather than the reactive approach of cost-accounting measures and will help sensitise management to environmental "dynamism" (Kaplan, 1983). In the same vein, Kaplan and Norton (1992) argued that:

"Executives also understand that traditional financial accounting measures like return-on-investment and earnings-per-share can give misleading signals for continuous improvement and innovation – activities today's competitive environment demands. The traditional financial performance measures worked well for the industrial era, but they are out of step with the skills and competencies companies are trying to master today."

The argument towards the disaggregation of productivity measures by hotel department/operation is reinforced by Baker and Riley (1994). They, after reviewing the productivity results of the NEDC study, concluded that a model of productivity in hotels needs to incorporate, if necessary as sub-models, explicit recognition that a hotel is made up of different departments, with different characteristics, with different factors determining efficiency. Moreover, the consideration of several partial ratios at the same time is required since partial metrics fail to take into consideration multiple inputs/outputs at the same time and any trade off that might exist between them. The latter though is very laborious and some times may lead to conflicting results.

Considering the different ways that productivity can be calculated, Johns and Wheeler (1991) summarised the revenue and cost related productivity ratios that can be measured at each hotel department as in Figures 2.2.2.2.c and 2.2.2.2.d.

Figure 2.2.2.2.c Revenue related productivity ratios per hotel department

Ratios emphasizing sales revenue

- **rooms division quantitative measures:**
  - occupancy percentage and double occupancy (on a daily, weekly, monthly or annual basis). The former is calculated by dividing the rooms used during a period (a night, a week) by the rooms available during that period and multiplying by 100, while double occupancy is sometimes expressed as a room density index by dividing the total number of guests for a period by the total rooms occupied during that period.
  - Guest/bed/sleeper occupancy is an indication of the utilisation of sleeping accommodation and may be calculated on a daily, weekly, monthly or annual basis as:
    - (Beds sold : Beds available) X 100
  - Maximum apartment revenue (MAR) or room sales potential can be calculated on a daily, weekly, monthly or annual basis and is the relationship between actual and potential room sales, the latter being calculated on the basis of published tariffs.
  - Average room rate per room occupied is calculated daily by dividing rooms revenue by the number of rooms occupied.
  - Average room rate per guest is calculated daily by dividing revenue from rooms by the number of guests and is affected by double occupancy rate.
  - Room sales per front-desk clerk per day week or month is a productivity measure that can be compared against a standard.
  - Average spend of each guest is calculated by dividing the total revenue by the number of customers during a period.
  - Room occupancy percentages by key segments, by business mix, etc, can also be calculated by breaking down room occupancy percentages into business, conference, full rate and so on. Sales revenue can be broken down on a similar basis.
- **Food and beverage operations: quantitative measures**
  - Restaurant occupancy (by meal or by day) is the number of covers during a meal period divided by the restaurant seating capacity.
  - Average spending power (US "average check") is calculated by dividing food and beverage revenue by the number of meals served
  - Sales revenue per employee can be calculated per meal period, day, week or month or number of guests served per waiter.
  - Percentage of beverage to food revenue.
  - Percentage of food/beverage to rooms revenue may also include revenue from minor operated departments.

Source: Johns and Wheeler (1991)

Figure 2.2.2.2.d Cost related productivity ratios per hotel department

Ratios emphasising costs in:

Rooms division

Wages	: rooms revenue to rooms sales
Laundry	: weekly cost to total rooms revenue
Cost of servicing	: twin room to net room rate (includes wages, guest supplies and laundry)
Rooms trading profit:	sales less wages and material cost to sales

Food department

Food department wages	: restaurants
(% of food sales)	: coffee shop
	breakfasts
	banqueting
material cost	: coffee shop or medium sized restaurant
(% of food sales)	: luxury restaurant
"Cost per dollar sale"	: steak bars
food trading profit	: "cash gross profit" (sales less cost of materials and wages to sales)
food stock turnover per year	

Beverage department

Similar ratios or percentages to those of food department, applied to bar operation and beverage sales.

Other departments

Administration and general wages/total sales
Advertising and sales promotion costs/total sales
Property operation, maintenance and energy costs/total sales
Fixed charges/total sales
Net profit/total sales
Net profit/capital employed (return on investment)
Monthly debts/total annual sales

Source: Johns and Wheeler (1991)

2.2.3 Selecting measurement units of inputs/outputs

The conceptualisation of productivity and the dimensions that this is considered to include (e.g. quality, effectiveness, efficiency) influence the selection of the units used for measuring the inputs/outputs of the productivity ratios. It is generally agreed that quantitative measures reflect a quantitative approach to productivity while a total factor approach would require more sophisticated and qualitative measures. There are though arguments supporting the view that aggregate financial metrics incorporate and measure productivity dimensions such as quality and effectiveness, although they are unable to distinguish the effect of each dimension and factor on productivity improvement and differences.

Once the boundary of measurement has been determined, Ball et al (1986) noted that it is a fairly straightforward task to identify appropriate financial and other relevant quantitative measures. Their approach involved classifying measures into three main categories of measurement:

- financial, calculated using financial factors for both input and output;
- physical, calculated using physical factors for both input and output;
- combination, calculated using a physical and a financial factor.

Several authors have cited productivity measures in the context of the hospitality industry (e.g. Coltman, 1980; Mali, 1978; Medlik, 1980; Pavesik, 1983; Powers and Powers, 1984; Sandler, 1982). Examples of productivity metrics in the hospitality industry identified by Sasser and Richardson (1996) are given in Table 2.2.3.a.

Table 2.2.3.a Examples of productivity measurements

Financial measurement	Physical measurement	Combined measurement
• profit / sales revenue • sales revenue / labour costs	• Rooms occupancy • Covers served per chef • Covers served per waiter • Guests / staff • Floor space per guest • Electricity consumption per guest • kilograms of chips prepared as a percentage of kilograms of potatoes used • rooms cleaned per hour	• physical outputs o rooms sold o guests served o bar guests o sales revenue • financial output o sales revenue • physical input o staffing levels o man-hours worked o rooms available • financial inputs o labour costs o material costs o capital expenditure

Source: Sasser and Richardson (1996)

Ball et al (1986) extended and summarised work of previous authors by constructing productivity boundaries around different input classifications identified as labour, energy, capital and raw material and by giving examples of productivity measures available for hotels for each of these boundaries (Table 2.2.3.b). The choice of which measures to use may appear confusing, however, each measure relates to different aspects of performance and to different organisational activities.

Table 2.2.3.b Examples ratios of hotel productivity

	Physical measures	Physical/financial measures combined	Financial measures
Labour measures	kitchen meals produced / No. kitchen staff	Restaurant revenue / Hours worked in restaurant	Banqueting revenue / Banqueting payroll
	Housecount / Total employee hours	Total rooms sales / Total reception employees	Hotel revenue / Total management salaries
	Restaurant covers / Hours worked in restaurant	Total rooms sales / Chambermaid day	total value added / hotel payroll
Energy measures	Total guest rooms / Total kilowatt hours	No. cooked meals / total cooking costs	Hotel revenue / Total energy cost
Capital measures	Total hotel customers / Square foot of hotel	No. rooms sold / Total capital expenditure	Net profit after tax / Equity capital
Raw material measures	Chips prepared (lb) / potatoes used (lb)	No. bar customers / cost of liquor used	Food revenue / cost of food consumed
Total factor measures	No. satisfied hotel customers / Total no. hotel customers	Housecount / Cost of contributing resources	Net profit after tax / cost of contributing resources

Source: Ball et al (1986)

Such a quantitative approach to productivity measurement seems to include only the tangible aspects of inputs/outputs, ignoring intangible/qualitative issues. Moreover, it is generally agreed that as quality exists only in the customers' mind, it may only be measured by such "proxies" as responses to customers' questionnaires. Moreover, as quality is at best a very difficult aspect to define, its measurement tends to focus upon customer attitudes and "satisfaction".

As a result, several hospitality operators carry out quality measurement as an ongoing control activity. For example, negative customer reaction is often recorded by logging the quantity and nature of complaints received and techniques as semantic differentials are used to measure the strength of customer feeling and attitude towards intangible aspects of quality, such as "ambience" or the friendliness of service staff. Moreover, quality control techniques, such as the use of standard packages, service audits and direct customer feedback mechanisms, are used to maintain and ensure quality of output. Olsen and Meyer (1987) argued the importance of these aspects by noting that one of the most important elements of productivity measurement is the extent to which the actual service transaction is productive and the degree to which customers' participation in the process affects productivity.

In theory, as in practice, Packer (1983) illustrated how, where the product is intangible, researchers have begun to incorporate subjective assessments. For example, statistical techniques such as factor analysis and hierarchical cluster analysis may be applied to the questionnaire responses supplied by people associated with an organisation. The design of the questionnaire should be closely linked to the goals of the organisation and the purpose for which the productivity data are required, e.g. operational or strategic planning, Witt and Witt (1989). Perceptual mapping of the results gives a picture of the abstract concepts used by managers to evaluate work effectiveness. As Packer (1983, p.49) claimed:

"The perceptual mapping technique thus measures the intangibles that managers instinctively think about – abstract concepts such as quality – and not just factors that happen to be objective and easily countable. As a result, this technique can measure productivity and effectiveness even in organisations that produce entirely intangible output"

However, several ways have been proposed for including quality considerations within quantitative productivity ratios. Ball and Johnson (1994) argued that the adjustment of output to include the number of usable, saleable or acceptable outputs reflects qualitative issues. This in the case of services could mean using the number of satisfied customers served rather than just the number of customers served. Interestingly, the proposed example of a total factor physical productivity measure for an hotel proposed by Ball et al (1986) is the following:

$$\frac{\text{number of satisfied customers}}{\text{total number of hotel customers}}$$

Although described as a physical measure, the notion of "satisfied customers" implicitly incorporates an intangible aspect of the output. The "hardness" of the number depends upon how effectively these satisfied customers can in fact be identified and counted. While customer satisfaction can be and is measured in practice, it is a concept that clearly goes beyond what would normally be considered as physical because quality measurement:

- necessitates the incorporation of qualitative measurement with all its inherent difficulties;
- can be derived as a composite index of more specific satisfaction measures, which would involve evaluating customer reaction both to aspects of the hospitality environment and to important operational features (Rimmington and Clark, 1996).

Therefore, as Johns and Wheeler (1991) argued the accuracy of quality measurement is often doubtful and the units in which it is measured are not comparable with those of quantity. Because of that, the total factor productivity expression as quantity X quality (e.g. no. of covers X attitude rating) is meaningless except if it is used as a comparison with other studies conducted by the same methodology in the same hotel. Dittmer and Griffin (1984) also recommended the approach of separately measuring and comparing quantity, resource cost and quality, but they also highlighted that such an approach is only useful as long as only one of the three factors changes at a time.

Heap (1992) was also a supporter of measuring the qualitative aspects of productivity and advocated a total factor conceptualisation of productivity which he called "top-line productivity" and defined it as a composite of output factors reflecting customer satisfaction (the "top-line") divided by input. Heap (1992) argued the incorporation of all factors that impinge upon the output side of the productivity equation through their contribution to value as perceived by the customer and proposed the following way of calculating such a productivity metric.

According to Heap, top line factors should be identified, measured and classified into the categories of functionality, reliability and aesthetics. Composite indices are then combined with an index based upon the normal financial measure of output or throughput to give a new weighted index. In Heap's worked example, the index based on financial output is given a 70% weighting, whereas 30% weighting is given to the top-line factors.

Top-line productivity index = financial productivity index (70%) + functionality index (15%) + reliability index (9%) + aesthetics (6%)

However, this approach shares the major limitation of multi-factor ratio approaches mentioned in the literature. This is the subjectivity in setting the end-point weighting, which is inescapable even if quantitative measures are able to be devised for individual top-line factors. Heap's method has though another caveat. Renaghan (1981) advocated that customers perceive the hotel as a whole, rather than as a series of isolated variables. In this vein, this can lead to problems in measuring productivity as a series of single discrete aspects, even if quality criteria are identified, similar to the problems encountered when partial measurements are used in order to derive a total factor productivity.

Because of the difficulties involved with the separate measurement of quantitative and qualitative aspects in productivity measurement some authors have followed a different approach. Rimmington and Clark (1996) argued that the truly quantitative aggregate "broad" measures such as value added in fact implicitly encapsulate intangible qualitative performance. This is because in the long term, only if intangibles are being delivered in a way that customers find acceptable can value added be achieved and sustained at its potential. The Hotel and Catering Tourism Committee (1989) of the International Labour Organisation also recommended measuring hospitality output in the form of value added, which was described as the only measure that can be used with reasonable effectiveness and reliability to compare one enterprise with another. Medlik (1989), who defined output as value added at factor cost (constant prices) and output per head as value added per full-time equivalent person employed, also supported this view. He also stated that the advantage of using a value-added output measure is that it enables account to be taken of the costs of resources (through contribution to profit), rather than just sales revenue.

Rimmington and Clark (1996, p. 198) extended their argument suggesting that broad financial measures can also represent aggregates of both tangible and intangible productivity performance. To support this view they gave the example of return on capital, i.e. profit achieved / capital employed, whereby although the "total factor" measure is purely financial, yet it can be held to represent both tangible and intangible aspects of performance. This is because only if the intangibles are as they should be will customer levels be sustained and income earned and only if the tangibles are as they should be will income and costs be controlled in such a way that profit is produced at the required rate in relation to the capital employed.

Johns and Wheeler (1991) also argued that quantitative sales-related outputs provide a yardstick against which an organisation's effectiveness can be measured and they are primarily accounting and control procedures, concerned with optimising product-based revenue. This is because quantitative sales-related outputs imply a sales concept of market orientation, as defined by Kotler (1988), i.e. a product orientation backed by selling promotions aimed at generating high sales as the key to achieving high profits. Moreover, the marketing concept is a consumer needs orientation backed by integrated marketing aimed at generating consumer satisfaction as the key to satisfying organisational goals. In other words, quantitative sales-related outputs incorporate qualitative issues, which since they in turn aim at customer satisfaction, i.e. an organisational goal, they also measure organisational effectiveness. This argument is similar to previous analysed debates advocating the relationship between the productivity dimensions, i.e. quality and effectiveness. In this vein, Johns and Wheeler (1991) argued that repeat sales may be used as surrogate measures of satisfaction and a better measure of daily, weekly, annual etc sales.

Rimmington and Clark (1996) also argued that sales and activity-related output measures directly reflect effectiveness. This is because effectiveness refers more to outputs (do the right thing) rather than inputs (do things rights) that refer more to efficiency. Thus, measures concerned primarily with an emphasis on outputs rather than inputs directly reflect effectiveness. Sales and activity-related output fit in this category and some examples are given in Table 2.2.3.c.

Table 2.2.3.c Revenue related and activity output related ratios reflecting effectiveness

Revenue-related	Activity related
• total revenue; • total revenue/number of covers (seats) available ; • total revenue/number of operating hours; • total revenue/total meals served; • total revenue/metres squared of trading area.	• total meals served; • total meals served/number of covers (seats) available; • total meals served/number of operating hours; • total meals served/metres squared of trading area.

Source: Rimmington and Clark (1996)

Gummesson (1998) also argued that broad financial measurements should reflect the effect of intermediate factors such as quality and profitability and illustrated in his "triple at play" model. In their balanced scorecard, Kaplan and Norton (1992) also regarded the aggregate financial measures as the final outcome of intermediate actions such as process improvement, customer satisfaction and organisation learning and innovation. Moreover, the applicability and the need for adopting the balanced scorecard in the hospitality industry was argued and analysed by Denton and White (2000).

Similar arguments exist regarding the measurement of the tangible and intangible elements of productivity inputs. For example, the use of labour hours as indicators of the labour input can be regarded as too narrow, because they fail to consider the heterogeneity of employees working. Workers have different skills, abilities, attitudes, levels of motivation, degrees of job satisfaction and loyalty, meaning that different labour makes different contributions to output. Thus, any conception of productivity that omits consideration of different employees and their different attributes and quality of input is short-sighted. However, the problems of incorporating these factors into input measures are far from clear and rarely mentioned, let alone resolved, in the literature (Ball, 1996). Strassmann (1999) argued that financial metrics such as labour payroll are a good surrogate of the qualitative aspects of knowledge workers and he so used labour costs for calculating information productivity, i.e. the productivity of knowledge based organisations in the information era.

Although such broad aggregate measures may represent both tangibles and intangibles, the relative effect of each dimension cannot be identified. Thus, good profit performance may result from, say, good performance in intangible areas resulting in revenue generation; on the other hand, this may have been more or less offset (in an unnoticed way) by inadequate control over tangible input resources. If such uncertainties need to be resolved then more precise measures are needed.

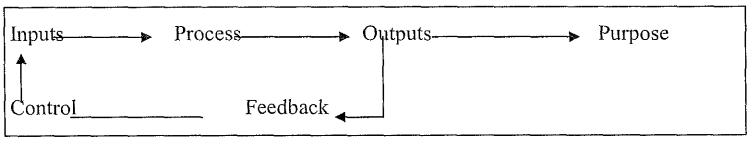
The fact that different units measure different issues was also mentioned by Johns (1997). He (1997, p. 119) argued that *"the units in which outputs and inputs are measured depend upon the stance from which these quantities are considered and they in turn affect the validity of the ratio"* and he gave the following examples. A measure of "100 units of output per day" from a factory says nothing about the quality or the value of the output while such as "output to the value of £50,000" is at the mercy of prevailing market conditions (e.g. inflation). Inputs are also subject to such variation as there are important distinctions to be made between such input measures as "per member of the workforce", "per man-hour" and "per £100 wages".

The fact that different metrics reflect different things and so have different information value is confirmed by Andersson's (1996) study. Andersson (1996) benchmarked the performance of different types of catering establishments, varying from fast food outlets to fine restaurants, by using both physical measures and aggregate measures in traditional ratio analysis and DEA analysis. Research findings showed that *the choice of measurement units seems to have a stronger effect on performance measures than the choice of items*, which was verified irrespective of the way that inputs/outputs were related, i.e. ratio analysis or DEA. More specifically, he (1996) argued that measures based on quantitative metrics, such as number of guests per day, number of Full Time Equivalent Employee (FTEE), reflect the narrow economic sense of productivity, (i.e. resource efficiency), while measures such as value added, salary per month, refer to a broader sense, (i.e. the "goal productivity"), that describes how well a process is able to achieve its ultimate goal. Thus, effectiveness is also incorporated within the "goal productivity" concept as goal attainment refers to effectiveness.

2.2.4 Ways of measuring the relationship between inputs and outputs

Once productivity inputs/outputs and their measurement have been determined, a way to relate and compare them should be found. Wilson (1993) stated that an organisation must be able to make a link between the outputs and inputs in the productivity equation, because only in this way can it "learn" and adapt its behaviour to ensure that it is progressing along an acceptable path towards its objectives. Thus, a correct balance of the productivity equation is vital to the health of a business organisation. Johns and Wheeler (1991) termed the link between outputs and inputs as a feedback loop and illustrated as in Figure 2.2.4.a. The feedback loop is an essential mechanism for varying the system's inputs and ensuring that its behaviour (as represented by the system's output) is consistent with business objectives. However, Sherman (1984, p.11) argued that although the need for managerial methods to enhance productivity in the service industry is apparent, techniques to accomplish these improvements have not been developed as they have for the manufacturing sector.

Figure 2.2.4.a Linking inputs with outputs



Source: Johns and Wheeler (1991), p. 50

Moreover, the two previous problems regarding the measurement of productivity, i.e. the identification of inputs/outputs and the determination of their measures, further complicate the third issue of productivity measurement, i.e. the development of a way indicating the relationship between inputs and outputs. In other words, the complexity of the relationship between inputs and outputs is affected by both the number and types of inputs/outputs as well as their measures, because different combinations between number and types of measures can result in a huge number of productivity metrics each one having its own information value and reflecting different things. In fact, there are several ways of comparing inputs and outputs and the most commonly used are analysed below.

2.2.4.1 Ratio analysis

Productivity metrics are very often in the form of ratios of one factor (output) to another factor (input). Ratio analysis has been used extensively in firm's productivity measurement for both normative and positive purposes (Whittington, 1980). The normative approach compares a firm's ratio to a benchmark such as an industry average to judge its performance. The positive approach uses ratios to predict future performance such as earnings, to assess the riskiness of the business, as well as to motivate management to perform towards predefined targets. However, although both the normative and positive approaches have had some success, there have been numerous methodological problems pointed out by Barnes (1987) and Fernandez-Castro and Smith (1990).

One of the prime reasons for using ratios is to control for the effect of the business size on the variables being studied so that one can compare different firms or compare a firm to an industry average. However, this control for size depends on the assumption of there being a proportionality between numerator and denominator (Shammari and Salimi, 1998, p. 6). This assumption may not be true in many cases (e.g. because of scale economies), thus leading to erroneous conclusions being drawn from ratio analysis.

An overall ratio, such as revenue/total costs, may be a reliable measure of efficiency but it gives no indication in itself of whether a low ratio of a particular unit is due to external factors, management practices or inefficient use of resources. In particular, there is no indication of the potential for improvement. A ratio is also only a number of its own that conveys little information; so it needs to be compared with, or put into the context of, some other number, either a quantity in another organisation (or the same quantity for another time period) or a related quantity in the same organisation.

However, ratios only give a partial or incomplete picture of a company's health and so, they do not provide enough information about the various dimensions of performance of a firm. Ratios are partial measures and might be misleading as each one presents a unit in a very different light. For example, costs per transaction and staff per sales ratios can be calculated, but the problem with these ratios is that the mix of outputs is not considered (Sherman, 1981, p. 12).

When using the ratio approach, the measurement of productivity is enhanced when a series of outputs to inputs ratios are developed. Considering many ratios though is costly and there may be conflicting signals emerging from competing ratios (Shammary and Salimi, 1998, p.6). Aggregation of ratios is usually avoided because it requires weighting the ratios in some fashion and any such weighting is ultimately arbitrary since there is a lack of agreement on the relative importance of various types of inputs and outputs (Weber, 1996, p. 41). Thus, some units could be better than average by certain measures but poorer than average by others. So, it is difficult for analysts not only to present an overall picture when taking many factors into account, but also to decide which factors these should be.

Another problem that arises with ratio analysis is the choice of a benchmark against which to compare a univariate or multivariate score from ratio analysis. The choice of benchmark depends on costs to a user of an error in prediction and different users may require different benchmarks for different purposes. However, this is not explicitly considered in most studies using ratio analysis (Fernandez-Castro and Smith, 1994).

A crucial problem of measuring productivity with ratio analysis is the fact that some ratios may compare outputs to inputs that are not directly related, i.e. the input taken into consideration is not solely responsible and hence accountable for the level of the output that is being compared. For example, a receptionist may sit doing nothing productive for a part of the day because there are no customers to serve. Service employees' productivity is though determined to a considerable degree by the variability of demand during the period of the time rather than total demand in that period (Blois, 1984). Hence, the assessment of employees by a sales per receptionist ratio may result in significant negative behavioural effects, e.g. demotivation, which in turn may negatively affect productivity.

This problem is more evident in the case of partial productivity ratios whereby not all inputs/outputs and their features intangibles or intangibles are taken into consideration. Andersson (1996) claimed that the use of key partial ratios for comparisons between various production units are bound to give a variety of answers to a one-dimensional question which in turn often gives a feeling of incompleteness. However, when several ratios are used simultaneously in order to overcome such difficulties, the picture usually becomes less incomplete but often more contradictory.

Another problem regarding the use of ratio analysis for productivity measurement is the fact that depending on the approach that the ratio adopts, i.e. either revenue-related or cost-related, its interpretations would have different behavioural effects and so different policies and guidelines aiming at productivity improvement.

Smith (1993) proposed three categories of the misuse or misspecification of traditional productivity ratio measures. First, the wide range and number of measures used can lead to tunnel vision, myopia, sub-optimisation or ossification. For example, by concentrating on metrics such as occupancy and ARR that emphasise only one dimension that can drive performance [e.g. physical assets (rooms) only and not customer assets (e.g. RePAC)], behaviour/actions and control will be taken to improve only the measured dimension. Second, there is the proliferation problem, i.e. where in order to avoid the first caveat, a lot of measures are used that they may cease to bring any meaning to the situation. And thirdly, there is the problem of the incommensurability of the performance measures and targets with the objectives of the organisation that again leads to the inappropriate development of the organisation. Actions for the improvement of different measures may come in to conflict with each other and with the actions of strategy implementation and so, there is a need to ensure that measures, targets and objectives are aligned and commensurate with organisational strategy and its implementation actions.

Overall, weaknesses of ratio measurement are summarised as following:

- One dimensional perspective, giving an extremely limited perspective on overall efficiency;
- Selection of the ratio to use is entirely subjective- there are many ways to "cut the cake";
- People tend to focus on the ratio that tells the story they want to hear;
- Strategies can become fixated around a given performance ratio;
- No formal method of looking for gradual shifts in emphasis between competing world views (or ratios).

2.2.4.2 Multiple-factors ratios

In an attempt to face the proliferation problem, i.e. to reduce multiple measures into a single measure, some researchers use multiple-factors ratios with the use of weights. In particular, a composite measure is calculated by the weighted sum of the key ratios (e.g. Heap's top-line productivity index, 1992). For example, some economists developed a viability indicator that has become known as the z-score (or multi-criteria analysis). This is a composite measure comprising the weighted sum of some of the key financial ratios. A typical z-score might be computed as (Norman and Stoker, 1991, p. 8):

z-score = a + b (ratio 1) + c (ratio 2) + d (ratio 3)
where a, b, c and d are constants (forms of weighting factors) that reflect the "relative importance" of the individuals ratios.

In this case the difficulty exists in determining weights and interpreting the composite measure. The limitations of multi-criteria analysis are summarised as follows (Trait, 19/11/99):

- Designing the structure of the model is a creative, time consuming task;
- Weights are (usually) subjectively assigned to the various criteria – leading to an a priori assessment of relative importance;

- Individual entities are not portrayed in their best possible light, leading to disagreements about the model;
- It is difficult to define "best practice" behaviour as peers are not readily identifiable;
- Although multi-criteria analysis is more suitable for problems involving few units with many criteria, it is conceptually related to DEA.

2.2.4.3 Unit costs

The most common alternative techniques are unit costs and regression analysis. The unit cost approach attempts to apportion cost to each output from which a cost per unit output can be calculated. Cost apportionment is straight forward for elements of costs such as product buying costs, but assumptions need to be made where costs such as those incurred for staff and premises are shared by the product groups. The quality of the results depends upon the accuracy of the assumptions. The limitations of the unit cost approach are (Norman and Stoker, 1991) that it is almost impossible to apportion costs to revenue growth and that there is no way to accommodate the breakdown of cost into controllable and uncontrollable elements. Moreover, the application and usefulness of this technique in the service industry is even less evident. Sherman (1984, p. 11) argued that although manufacturing firms can generally determine with some precision the standard or efficient cost of their product and then use it to identify operating inefficiencies by analysing differences between actual cost and standard cost through classical cost accounting variance analyses, service organizations have not developed standard cost estimates of outputs. This is firstly because it is difficult to identify the specific resources required to provide a specific service output and secondly because the people being evaluated against a standard cost may not accept or agree on a standard because of the professional judgment involved in providing each type of service (Sherman, 1984, p.12). For example, the professional might argue that no two audits, heart operations and customer service are alike, so that no standard or efficient input level can be identified as a basis for evaluating the efficiency of producing such services. A further limitation is that apportionment is impossible when inputs that are not cost based are used, e.g. competition and population.

2.2.4.4 Regression analysis

Regression analysis can overcome problems of apportionment and the use of factors that are not cost based, but it still has limitations which would preclude some of the analyses that are possible using DEA. Regression extends the one-input/one-output structure of a simple ratio to one-input only / many-outputs or one-output only /many-inputs. This technique determines an "average" performance and individual performance is "benchmarked" from this perspective. Regression model provides the basis for identifying important performance drivers (variables) as well as peers by using multidimensional scaling techniques.

However, the restriction to either a single output or a single input factor is the main limitation of regression analysis. A further feature of regression analysis is that it is a parametric technique. In other words, there is a need to assume a mathematical form for the relationship that is derived. Further, it is difficult to interpret the real meaning of "average" performance and tie it to actual behaviour – an important issue as this forms the basis of the performance evaluations. And finally, extreme erroneous values in the data are difficult to spot and they can unduly influence the regression model.

2.2.4.5 Production frontiers: parametric and non parametric techniques

Given the number of possible ratios, it is clear that there is a need to condense several measurements into a single measure through multidimensional analysis that can combine two or more key ratios into one measurement (Heap, 1992; Andersson, 1996). Moreover, the productivity metric that would take into consideration multiple inputs and outputs should be computed in way that it does not directly link/relate certain inputs with outputs (since the effect of some inputs on outputs may not be directly or easily understood) but it would rather highlight the interrelationships and trade off between all of them (Blois, 1984).

A number of fairly similar methods respond to this need, such as the Tornqvist index (Tornqvist, 1936), the Malmquist index (Malmquist, 1953), technical and price efficiency (Farrell, 1957), Data Envelopment Analysis (DEA, Charnes et al, 1978), hyperbolic graph efficiency and Russell input measure of technical efficiency (Fare et al, 1985) and free disposal hull efficiency (Tulkens, 1990).

These methods are all based on production functions where output is a function of input. There are though two empirical approaches to the measurement of efficiency based on the above concept of frontier production function. The first, favoured by most economists, is parametric (either stochastic or deterministic). Here, the form of the production function (the isoquant) is either assumed to be known or is estimated statistically. The advantages of this approach are that any hypotheses can be tested with statistical rigour and that relationships between inputs and outputs follow functional forms. However, in many cases there is no known functional form for the production function. So it may be inappropriate to talk in terms of such a "production" function and a non-parametric approach for constructing the production function may be used. Under this approach no assumptions are made about the form of the production function. This will necessarily be piecewise linear, and as such, would be an approximation to the "true" function, if one existed.

In the parametric approach the functional form usually chosen is Cobb-Douglas. In this context the Cobb-Douglas functions are estimated by "averaging" statistical techniques, such as regression. Each unit is then compared with an average, but it is not immediately clear what this "average" represents. It clearly does not refer to a firm of "average size", nor indeed, to a firm having "average means at its disposal" (or "average technology") since it is assumed for these purposes that we are investigating the efficiency with which organisations utilise the resources available, and the environment in which it finds itself, in producing its outputs. In other words, we should have "made allowances" for any encouraging or inhibiting factors enjoyed by the individual units. In reality, we are making comparisons with an average figure that in reality does not correspond to any real unit from our sample.

Instead of comparisons with some unspecified average, it is better to establish norms of best achieved practice to which those units that fall short can aspire. To this end, the pursuit of a non-parametric extension to frontier analysis and in particular the Data Envelopment Analysis (DEA) approach is considered to be a more powerful technique. DEA constructs a frontier function in a piecewise linear approach by comparing like units with like. So, DEA uses the production units that are "best in its class" as reference material, a method very much in line with the basic ideas underlying the concept of benchmarking (Camp, 1989; Spendolini, 1992). DEA has the ability to compare the efficiency of multiple service units that provide similar services by explicitly considering their use of multiple inputs (i.e. resources) to produce multiple outputs (i.e. services). In this way, DEA also circumvents the need to develop standard costs for each service, because it can incorporate multiple inputs and multiple outputs into both the numerator and the denominator of the efficiency ratio without the need for conversion to a common dollar basis. Sherman (1984, p.11) is one of the first advocates that highlighted the appropriateness of DEA in measuring the efficiency of service businesses by arguing that:

"productivity measurement of these businesses requires techniques that are more sensitive than accounting and ratio measures and that can explicitly consider the mix of service outputs produced"

Moreover, DEA can also consider/control external factors that can affect productivity overcoming in some extent the *ceteris paribus* problem of productivity measurement. Hence, DEA can assess performance against: a) desired objectives; b) the means used to attain objectives; and c) environmental factors affecting success. Overall, DEA can meet the objectives that Lewin and Minton (1986) identified. Specifically, in seeking to define a research agenda for determining organisational effectiveness, Lewin and Minton (1986, p. 529) argued that a theory-based mathematics technique is required which would calculate the relative effectiveness of an organisation (over time or in comparison to other referent organisations) and would be:

- *"Capable of analytically identifying relatively most effective organisations in comparison to relatively least effective organisations;*
- *Capable of deriving a single summary measure of relative effectiveness of organisations in terms of their utilisation of resources and their environmental factors to produce desired outcomes;*
- *Able to handle noncommensurate, conflicting multiple outcome measures, multiple resource factors and multiple environmental factors outside the control of the organisation being evaluated; and not be dependent on a set of a priori weights or prices for the resources utilised, environmental factors or outcome measures;*
- *Able to handle qualitative factors such as participant satisfaction, extent of information processing available, degree of competition etc;*
- *Able to provide insights as to factors which contribute to relative effectiveness ratings; and*
- *Able to maintain equity in the evaluation."*

However, a more detailed analysis of how DEA can be applied and its advantages for productivity measurement is given in the chapter on DEA.

2.3 Factors influencing productivity

The aforementioned focused on the interpretation of productivity as a concept, with associated implications for its direct measurement. However, consideration must also be given to the conditions that bring about the achieved level of productivity for two major reasons. First, organisations aiming to improve productivity levels, need also to measure the presence and extent of conditions that it believes are likely to bring this about (Rimmington and Clark, 1996). Moreover, productivity measurement and control has to face the *ceteris paribus* problem, i.e. the need to hold other influences constant when examining the impact of a particular factor (Witt and Witt, 1989). Therefore, the factors affecting productivity should be identified. However, these are numerous (e.g. labour, grade and type of hotel, product/service mix, nature of the technical systems and remuneration) and highly interdependent and so, it is difficult to identify the effect of one particular influence. Moreover, the literature contains several examples where productivity has been demonstrated to be influenced by identified independent variables.

Several studies that focused on the measurement of productivity have attempted to examine the effects of individuals factors. For example, Van der Hoeven and Thurik (1984) studied labour productivity in a number of German and Dutch hotels using an operations research model. They found that, in general, labour requirements consisted of two components: a fixed threshold level and a sliding level, which varied in proportion to the volume of business. The fixed threshold level varied depending largely on the size and rating of the hotel. The rate at which the sliding level varied depended on various factors, including the size and rating of the hotel, but also the rates of staff pay and the average length of guests' stay. It was also found that productivity was influenced by advanced booking, which enabled hotel managers to plan and to match supply to demand. In addition, economies of scale could be obtained for large affiliated hotels because of their purchasing power and the advantages of inventory management systems.

The National Institute of Economics and Social Research (NIESR) (1989) undertook a comparative study of hotels in Great Britain and Germany. The study investigated a small but carefully matched sample of 14 medium-sized hotels in UK and 24 in West Germany, and looked at the utilisation of human and physical resources as well as at training. The level of qualified manpower was found to be main factor affecting hotel performance in the two countries. German hotels seemed to have higher levels of training and lower staffing requirements as well as to make use of labour-saving equipment and ergonomically designed rooms. The NIESR made many qualitative comparisons between UK and German hotels, but in quantifying differences in levels of productivity, it concentrated mainly on staffing levels, particularly the ratio of guest nights to FTEE. It is however, difficult to pinpoint the causes of lower levels of staff productivity if other factors are ignored. Critically, the NIESR ignored the financial contribution of staff, which ultimately determines the viability of a hotel. Concentrating on staff productivity, conclusions were drawn about training issues, but ignored the possible impact of other factors like marketing. However, if a hotel is poorly marketed and is half empty as a result, no amount of staff training will increase productivity.

The National Economic Development Council (NEDC) (1992) published a comprehensive report, which attempted to build on the earlier work of the NIESR. Its project compared productivity levels in matched samples of 20 UK, French and German hotels, using a wider variety of measurements: physical, financial and combinations of these. The main measurements used were: (physical) FTEE to available rooms, (financial) ratio of profit to sales; and (combination) sales revenue per room, costs per room, value added per FTEE, sales revenue per FTEE and costs per FTEE. Averages of each measurement for all hotels in each country were calculated and then used to compare productivity between three countries. The NEDC study, however, only looked at hotels in each of the three countries that were on the Horwath Consulting Client database, which were unlikely to be representative of the population of hotels in the UK, Germany and France. The NEDC also carried out a survey of 144 UK hotels to ascertain opinions and productivity practices, which revealed an apparent lack of knowledge and use of management techniques. It was concluded that there was insufficient short-term forecasting of workload, and corresponding matching of workforce rostering to match the workload, in the UK. It was thus recommended to conduct a major project to determine best practices and to demonstrate the benefits that they can yield.

The lower productivity of British hotels was generally attributed to the limited use of appropriate management due to the lower training of British hotel managers. Witt and Clark (1990) surveyed 167 hotel managers to investigate how widespread were the use of various techniques. They found that 40 percent of respondents were aware of and claimed to use occasionally or frequently productivity management techniques such as activity sampling, classification coding, critical path analysis and time study. It is possible, however, that these techniques were used but under different names. Lee-Ross and Ingold (1994) regarded the knowledge and understanding of productivity of managers in small hotels as questionable, as they pointed out that previous studies of productivity within the hotel industry had not taken into account hotels of fewer than 10 bedrooms, which make up some 80 per cent of the UK hotel industry.

Witt and Witt (1989) also presented an impressive body of evidence that poor productivity in the hospitality industry is related to a lack of understanding and application of quantitative and analytical techniques. Many respondents in the study indicated that they did not know of the techniques, while only large groups, capable of supporting a management services department admitted to using the techniques to a significant extent. In the same vein, Guerrier and Lockwood (1988) also commented on the poor productivity in the hotel sector attributing it to the management style of hotel managers:

"Traditionally the development of hotel managers encourages a "being there" style and discourages reflection and planning... Their "hands on" bias may make them reluctant to spend time on and even afraid of, paperwork and figurework."

In a more recent international study conducted by the McKinsey Global Institute (1998), it was identified that the UK hotel industry had only 53% of the productivity levels of the US industry and 60% of French hotels. Two major reasons contributing to such performance differences were identified. First, the age of the property (75% of UK hotels are over 40 years old), which makes them less efficient to operate than newer purpose-build properties. It is argued that hotel age makes production processes such as cleaning rooms and organisation tasks in terms of storage space and its location less efficient. Secondly, low chain penetration in UK, which McKinsey suggested leads to "less use of standardised processes", which may lead to slow check-in/out, less efficient cleaning, worse staff scheduling. Moreover, hotel chains also benefit from scale and scope economies in purchasing, marketing and reservations ad they can attract and retain high calibrate staff. Other secondary factors affecting performance included the service mix (a relatively high proportion of food and beverage relative to accommodation sales, i.e. UK hotels are more likely to have restaurants which decrease productivity levels), hotel size (too many small hotels, a relatively big percentage of hotels in UK are of small size) and lack of international experience that enables an organisation to learn from other countries. Only a small percentage of UK hotels is owned by companies that operate internationally. Similarly, Dickens (1999) in reporting on the hotel productivity studies conducted by BDO Hospitality Consulting argued that enhanced managerial practices such as flexible staffing, information technology and yield management are some of the practices that are very likely to contribute to the lower productivity levels of provincial hotels relative to hotels in London (that are more likely to be of larger size and part of a chain).

Gathering data from 35 major hotel companies in Croatia during 1994 and 1998, Cizmar and Weber (2000) investigated the relationship between marketing effectiveness, (measured as occupancy and ARR), and business performance, (measured as net operating profit or loss) by simultaneously controlling for the effect of two factors: a) scope and intensity of marketing activities and b) the way marketing information was used in management processes. Their findings provided empirical evidence of the positive relationship between both the marketing performance indicators and: 1) hotel financial performance indicator and 2) the two controlling variables. A negative correlation between occupancy and the use of marketing information was reported which led them to the conclusion (p.236) that "*more informed and marketing oriented management achieves better results... management that is not completely aware of the importance of marketing information, achieves better occupancy, but followed with lower average prices and worse revenue*". Finally, findings also revealed a positive correlation between all variables and size of hotel as well as that marketing insufficiency was significantly influenced by:

- Undefined business and marketing strategies;
- Inappropriate internal marketing information systems;
- Insufficient management capabilities to use the existing information.

Results of this study provided evidence of the fact that the collection of marketing information in an appropriate marketing information system, its customer oriented use and the existence of capable management to use such information can crucially affect hotel performance. However, the use of marketing information was found to have a different impact on different indicators (e.g. occupancy, ARR, operating results), while the degree of its use and impact depended on hotel size. Therefore, in examining the relationship between ICT (and particularly the use of ICT and its by-product "information") and hotel productivity, it is important that ICT impacts on different productivity indicators are measured, while the impact of other factors is controlled. To that end, by using DEA for measuring productivity, one can identify the productivity factors that need improvement or contribute to enhanced performance while simultaneously control the impact of other factors, e.g. business variability, size of operation.

The Department of Employment Manpower Research Unit identified in their study (in Johns, 1997) the following eight major factors affecting staff levels in hotels and so productivity levels:

1. ownership may affect staffing by its influence on the scale of operation and through the owner's attitude to hotelkeeping. Group owned hotels tend to be larger and more standardised than the independent hotels, which tend to be more individualistic;
2. size of hotel (number of bedrooms, number of beds, number and size of restaurants, etc) determines the scale and type of operations and the extent to which economies of scale can be achieved. Large hotels tend to have a lower staff/guest ratio than medium-sized hotels. This ratio was also found to be low in smaller owner/managed hotels where the owner and his family generally work longer hours and employ fewer staff;
3. age and layout of the buildings affects the efficiency of hotel operations and therefore, the staffing levels. Modern purpose-built hotels with a view to ease and economy of operation can operate with fewer staff than older hotels, which are more difficult and expensive to operate;
4. range and type of facilities and services influence the number and type of staff required to provide them. Generally the greater the variety of food and beverage facilities and of other guest services within the hotel, the greater the staffing requirements;
5. methods by which hotel services are provided have a pronounced effect on the number and skills required to provide them. Hotel services may be provided personally by staff or through self-service and other non-personal methods with wide variations in required staffing. The use of ICT has a crucial play in that;
6. quality of staff has a bearing on their output and therefore, on the number of staff required to provide a particular volume and standard of hotel facilities and services. This is a matter of attitude, motivation, and training;
7. organisation influences the staffing of hotels through the division of tasks and responsibilities, the extent of use of labour-saving equipment, techniques and procedures, and the extent to which specialist contractors and suppliers are used for particular hotel requirements;
8. incidence of demand, annually, weekly and during the day, gives rise to annual, weekly and daily fluctuations in staffing requirements, which can be met to a varying extent by the employment of temporary, casual and part-time staff.

The crucial effect of demand variability on productivity was highlighted by Riley (1999). He (1999, p. 183) argued the "*the main casualty of the lack of conceptual clarity is not the nature of the outputs but that, for hotels, the output/input model is, in operational terms, reversed*". In other words, it is the output that drives input and so, the intangibility and the nature of output are a red herring in terms of output but their real importance is in their impact on inputs. However, previous studies seem to have ignored the stochastic nature of demand in the very short term (Riley, 1999). Demand fluctuations reflected in aggregate measures such as "seasonality" and average occupancy metrics tend to lose out short-term variations in demand. The latter however are salient to productivity. Riley (1999) argued that although measures such as gross indicators and physical units, e.g. number of guests, get closer to hotel operations than other measures, the former are underused in hotel studies. This study considers variation in demand by controlling for degree of business variability that is measured as composite metrics of weekly and annual variability in business in order to reflect both long-term and short-term demand fluctuations. Moreover, data of hotel inputs and outputs are gathered by both physical and monetary metrics.

According to Armistead et al (1988) the following service characteristics directly affect productivity levels and improvement strategies:

- Volume – of demand, i.e. total output over time;
- Variety – of service, i.e. in hotel service the product range;
- Variation – of demand over time, i.e. peaks and troughs in demand.

Jones (1990) added variability defined as the different demand for different products/services.

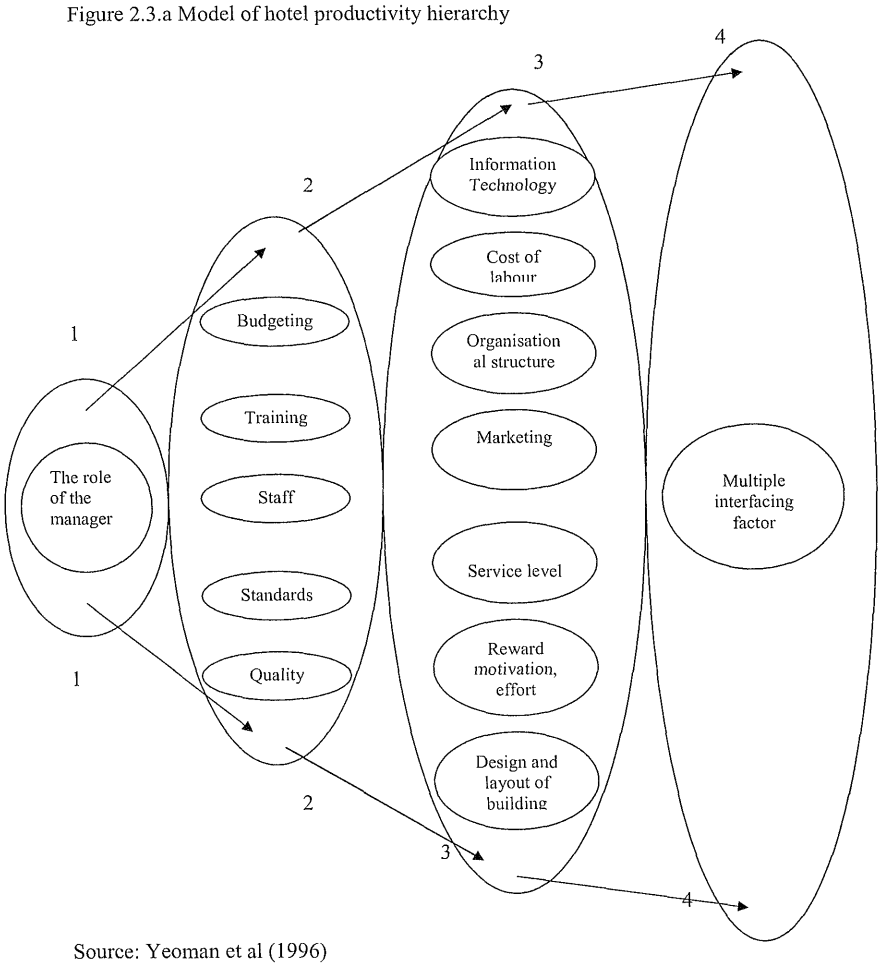
The impact of volume on input costs is the traditional economies of scale. In services, these relate to increased purchased power, spreading of central overheads, marketing economies and labour specialisation (Mill, 1988). There are similar influences on the efficient transformation of sources as well as "Learning effects". Furthermore high volumes also allow delivery system to balance so that all subsystems are operating at optimum levels. However, the level of variety offered may offset any potential productivity gains derived from high volume. As Armistead et al (1988) stated, high variety reduces volume per service line and requires specialised plant, equipment and employees, which is likely to reduce the efficiency and make more difficult their full utilisation.

Variation of demand implies that demand levels are difficult to be matched with resources levels, which may create under-used capacity, slack resources or lost opportunities to make revenue. The concept of variability suggests that not only will total demand vary, but also the demand for the range of services on offer will vary. Fluctuation in sales mix has an impact on sales costs by not only reducing potential economies of scale, but also by making the implementation of strategies designed to cope with variety more difficult. With regard to efficiency, the former also provides additional pressure for accurate forecasting of potential demand on some "last minute" flexibility over provision.

By surveying 240 properties of two prominent hotel chains in USA. Brown and Dev (1999) tried to investigate the effect of a hotel's service orientation, strategic orientation, ownership arrangement, management arrangement on productivity. Research findings show that while labour productivity was affected by size and ownership arrangement capital productivity was not. Management arrangement affected both labour and capital productivity while interestingly strategic orientation had no effect on either index of productivity.

By surveying hotel managers on their perceptions regarding factors that influence productivity, Yeoman et al (1996) also provided a summary of factors affecting productivity. These have been mapped into a model of hotel productivity hierarchy consisting of four levels of factors influencing productivity, whereby the influence of soft factors such as role of manager, training is also illustrated (Figure 2.3.a).

Figure 2.3.a Model of hotel productivity hierarchy



Source: Yeoman et al (1996)

The significant impact of soft factors in productivity levels was also illustrated in Clark's (1994) study. This is also so far, the only study found in the hospitality industry trying to investigate the impact of different technologies of operating systems on productivity. Specifically Clark (1994) investigated the impact of upstream factors as a result of research into achieved levels of labour productivity within the hospital food production service systems. Regression analysis was used to compare productivity of systems employing cook-chill and other labour-saving features with those operating conventionally. Although differences in overall productivity between different system types were clearly demonstrated, there was substantial deviation around the performance trend line for each individual system type. Because of that

Clark (1994) conducted case studies of units that possessed similar operating systems and equipment configurations whereby he (1994) identified that factors additional to the technical system being used were clearly influencing productivity in a significant way. Some of these additional factors were "soft system" factors relating to the management and development of human resources within the organisation and its culture, which are increasingly being recognised as important to the success of organisations. Rimmington and Clark (1996) provided some examples of such factors (Table 2.3.a).

Table 2.3.a "Upstream" productivity measurements in "soft system" areas

Area	Example of measures
Staff motivation	Absentee/turnover rates
Staff skill and training	Qualifications gained/courses attended
Management style	Leadership styles/personality measures
Organisation and culture	Span of control/hierarchical levels/style appraisal analysis

Source: Rimmington and Clark (1996)

Nonetheless, although many writers have acknowledged the complexity of productivity measurement in hotels and the need to take account of a wide range of factors that influence productivity, few, if any have attempted to take account of all these factors in a practical application. Past studies have typically resolved these difficulties by limiting the scope of their study to particular operations or business of the hotel (e. g. Prais' et al, 1989) or restaurant productivity (Ball et al, 1986) and by using a limited range of measures: for example, relating some element of output such as guest nights or covers to labour input (numbers of full-time employee equivalent).

2.4 Productivity measurement in previous studies

Managers, economists and others have attempted to accurately assess the efficiency of the hotel industry and provide robust firm-specific performance measures for many years. Baker and Riley (1994) identified the most commonly used indicators of performance in the hospitality industry, namely, average occupancy rates, average room/rates as indicators of performance, revenue/wage cost, gross profit/revenue, and net profit/revenue. There have also been several attempts to identify satisfactory productivity monitoring procedures (e.g. Ball et al., 1996), but although a range of ratios have been used to express specific limited aspects (Johns and Wheeler, 1991), no generally accepted means of productivity measurement exists in the hotel sector.

Various researchers attempted to measure hospitality productivity by focusing their studies upon more or less isolated factors. For example, Van der Hoeven and Thurik (1984) identify advanced bookings as an important contributor to productivity differences between European hotels, as it enables managers to plan and match supply to demand. They also noted the importance of economies of scale in affiliated hotels. By contrast, the National Institute of Economics and Social Research (NIESR, 1989) identified the differences in qualified manpower as the main source of productivity differences between hotels in Germany and the UK. A survey by the National Economic Development Council (NEDC, 1992) found that British hoteliers were comparatively ignorant of productivity management techniques, which was also confirmed by a survey of hotel managers by Witt and Clark (1990). However, Baker and Riley (1994) criticised the NIESR' study for paying inadequate attention to the stochastic nature of demand in hotels and restaurants, which is a major complicating factor in productivity measurement within this industry.

Wijeysinghe (1993) suggested a method for calculating breakeven room occupancy that provides accurate calculations. He also proposed a system of effective management, which he called the general indicator to hotel efficiency (GITHE), that can be used to analyse the source of loss and thus, give a better control of the business. Kimes (1989) recommended the basic concept of perishable asset revenue management (PARM), which determines the optimal trade-off between average daily rates and occupancy rates. The basic idea of PARM techniques involves charging the right price in order to select the right customers to fill each room, while achieving the highest possible revenues. Benefits from the PARM accrue in three main categories: overbooking, proper allocation among the numerous rate classes, and length of stay (LOS).

In applying PARM, some researchers (Lefever, 1988; Liberman and Yechiali, 1978; Rothstein, 1974) focused strictly on overbooking, while Relihan (1989) concentrated on how PARM could be used to make better pricing decisions. Weatherford and Bodily (1992) developed a taxonomy for length of stay (LOS) and Weatherford (1995) provided a sophisticated LOS decision rate for PARM situations with guests being allowed to stay for more than one night. However, the availability and calculation of reliable average occupancy and room rates is very difficult for many travel destinations. Moreover, as Lee (1984) pointed out these statistics might be confusing or deceptive even when they are available. This is because several studies have shown that occupancy and room rates have limited correlation (Arbel and Strebel, 1979; Greenberg, 1985, Wingenter et al, 1982/1983) and so, the overall industry trend is obviously not relevant if one indicator increases and the others decrease at the same time.

Van Doren and Gustke (1982) used lodging industry sales receipt information to gauge industry performance. In their study by measuring aggregate receipts and per capita receipts, they examined economic growth in various states and select standard metropolitan statistical areas. However, their technique does not provide a method of determining optimal performance, as cost efficiency issues were not examined. This is because yield management stresses the need to focus on profits and not revenues (Brotherton and Mooney, 1992;Donaghy et al, 1995).

Wassenaar and Stafford (1991) advocated the use of a lodging index indicator for the hotel/motel industry and defined it as the average revenue realised from each room, vacant or occupied, within a region or city during a given time period. They suggested that the index is particularly effective for local travel destinations where average occupancy and room rates are not available. However, although the technique combines average occupancy and room rates into a single indicator, it does not examine how efficiently firms are controlling costs.

Another common indicator is the labour-cost ratio, i.e. the ratio of payroll expenses to sales, which is commonly referred to as the labour-cost percentage. However, as this index can be easily distorted by changes in sales revenue and it cannot necessarily reflect efficiency and productivity. In addition, it is of limited value because it is an aggregate, non-specific figure and an accurate index of labour productivity requires multiple measurements such total labour hours, sales per labour hour and labour cost per hour. When used as a weekly basis to analyse payroll costs, these measurements offer far better tools for forecasting and adjusting labour costs.

Ball et al (1986) carried out a study in a sample of nine hotels, all four-star and in urban areas, offering similar facilities and services, and operated by the same company. They concentrated on the food and beverage departments because these had the most variation in levels of customer use, and therefore, it was believed, had potential for performance improvement. They stated that a hotel could increase its profitability by increasing its volume of business or by reducing its operating costs, but that ideally both issues should be addressed together. They recommended determining and measuring various inputs and outputs of a hotel in order to calculate productivity ratios and evaluate their significance. A wide range of measurements was used including different issues such as labour productivity (e.g. the ratio of number of meals cooked to number of kitchen staff and the ratio of sales revenue to payroll for different departments of the hotel), the use of raw materials (e. g. mass of chips produced against potatoes and the number of bar customers against the cost of liquor used) and capital measures (e.g. total hotel customers per square foot of hotel). Following a pilot study, they decided to concentrate on two measurements: revenue against numbers of full-time equivalent employees (FTEEs) and numbers of covers served against FTEEs. These were monitored on a month by month basis for the restaurant / coffee shop, for room service and for kitchen and stewards, over a period of two years for each of the nine hotels. Further analysis was proposed to investigate the causes of periods of good and poor performance. Similarly, hotel departments that seemed to have higher productivity could be compared with those with lower productivity, in an attempt to identify the reasons for this.

Brown and Dev (1999) argued that the most widely used measure of hotel productivity today is RevPAR (Revenue per available room). This metric derives from the combination of two hotel output metrics, occupancy rate and average daily rate (ADR), but it suffers from two key limitations: 1) it does not include revenue from other departments, e.g. F&B and 2) it does not take into account costs that are incurred to provide the requisite service level (additional guest service employees such as concierge etc). As the president of Ritz Carlton said (in Brown and Dev, 1999, p. 24):

"... I would like to maximise revenue and dollar profits, not just room-profit percentage. But the rest of the industry does not talk about non room income because it depresses their profit margins... I could increase my profit percentages by closing some restaurants and shops, but then I would be doing a disservice to our customers"

However, Brown and Dev (1999) questioned whether productivity measures should be modified in order to reflect the hotels' changing emphasis from a rooms' only orientation to full service orientation. They (1999) also suggested that sales per available room (SalesPAR) may be a more appropriate comparative statistic than simple RevPAR.

So, considering that metrics and measurement techniques that take into account costs and benefits from different sources are required, Brown and Dev (1999) used three inclusive indicators of hotels' output, namely total sales, gross operating profit and income before fixed charges. They (1999) argued that although these metrics overcome the limitations of the one-dimensional RevPAR output indicator, they provide summarised information. Brown and Dev (1999) used the number of full-time equivalent employees as a metric of hotel human resources and physical size as well as the number of rooms, as an indicator of a hotel's capital resources/inputs.

The majority of previous studies on productivity have so focused on the measurement and analysis of specific productivity ratios ignoring most times external factors influencing productivity. However, it is difficult to draw any conclusions about the relative productivity of the hotel industry without considering the mix and the nature of services provided. Measuring the technical efficiency of the industry requires techniques that are more sensitive than accounting and ratio measures, that can explicitly consider the mix of service outputs produced and that can control for external factors influencing productivity. Moreover, as hotel organisations have not developed standard cost estimates of outputs, it is difficult to identify operating inefficiencies by analysing differences between actual and standard costs through classical accounting variance analyses. Although the need for managerial methods to enhance productivity in the hotel industry is apparent, methods to accomplish these have not been developed as they have for other industries (Johns, 1997).

2.5 Conclusions

It was made evident that a general definition of productivity does not exist. Specifically, productivity conceptualisation depends on the theoretical backgrounds and paradigms from which it is viewed. So, although the different ways to productivity conceptualisation were categorised into two general approaches namely the total factor approach and the quantitative approach to productivity, conflicts still existed on the interpretation of these approaches to productivity definition. So, some argue that the differences between the total factor and partial approach to productivity refers to the consideration of both of intangibles and tangible inputs and outputs, others use the terms within the context of the financial/quantitative approach. In this contexts, a productivity definition would require to indicate: a) whether it refers to the inclusion of all inputs and outputs rather than the consideration of each input at a time (partial measures); or b) whether its metric refers to the measurement of both tangible as well as intangible features of the inputs/outputs regardless whether partial or total productivity ratios are calculated; or c) whether it considers other factors that may be external to the control of management but can crucially affect productivity, e.g. level of competition, location; or d) whether it considers all the previous factors or a combination of them.

Along the debate around productivity definition, several arguments have been developed regarding the relationship between productivity and the concepts of quality, effectiveness, performance and profitability. Deriving from a different theoretical perspective, each of these concepts gives a different contribution on how productivity should be defined and measured. The strong links between quality and productivity highlighted in the operation management literature stressed the need to include quality aspects in the productivity concept and adopt and to consider customer oriented productivity definitions. In the same vein, economic theory also argues the inclusion of qualitative and ultimate outputs by making a distinction between the concepts of efficiency and effectiveness. The first concentrates on the conversion of inputs into outputs, while the second stresses qualitative aspects and the ability of outputs to meet customers' needs and wants. Business management theories regarding performance/benchmarking issues highlight the need to measure productivity in relative terms (by establishing benchmarks, e.g. competitors) as well as consider both comparative performance measures and how exceptional performance is attained. Profitability metrics are argued to be good general and aggregate metrics of productivity, but for productivity benchmarking and improvement purposes they should be used in conjunction with other more detailed metrics. Finally, the relationships and links among all these concepts are summarised and illustrated in an overall framework that integrates all these productivity dimensions, while in the following chapter an operations management theory is analysed that unifies all these approaches and theories to productivity.

Difficulties do not exist only in productivity definition but also in its measurement. Indeed, the debates on productivity definition are reflected in the proliferation of productivity metrics and the different ways for measuring productivity. As it was argued that productivity is an overall concept that should consider the following interrelated dimensions (e.g. efficiency, effectiveness, quality and profitability), its measurement should reflect these dimensions. However, productivity measurement itself represents several difficulties and these are found throughout the productivity measurement process. Specifically, productivity measurement should address three difficulties namely the identification of inputs and outputs, the identification of metrics of inputs and outputs and the way that inputs and outputs are analysed.

The first problem is addressed when the level and unit of productivity analysis (i.e. aggregated metrics at hotel departmental level, or market segments or individual customer) are identified. Although aggregated and general productivity metrics can consider all productivity factors, they can obscure and hide certain dimensions and factors because they are not analytic. On the other hand, disaggregated productivity metrics can consider and reflect individual factors that can affect productivity at different levels, but reflect only a partial picture of hotel performance. Thus, there is a need to find a way to combine the advantages of both metrics, while eliminating their limitations. Regarding the problem referring to the units of outputs and inputs, financial metrics are argued to incorporate quality and effectiveness issues, while physical metrics are argued to focus on efficiency only (i.e. the simple conversion of inputs into outputs) and to downplay quality issues. An investigation into the third problem of productivity measurement illustrated that the frequently used methods for analysing inputs and outputs (e.g. ratio analysis, regression analysis, parametric techniques) have several limitations and disadvantages. In brief, ratio and regression analyses are limited in their ability to consider several inputs and outputs simultaneously, while the second also benchmark units relative to an average performing units that does not exist. Parametric methods tend to overcome these limitations, but they are limited in the fact that they compare units by assuming a production function. On the contrary, non-parametric techniques such as the DEA are not constrained by this limitation, because they construct a frontier function by comparing the like units of the sample with the like. DEA also has the advantage of considering environmental factors that can affect productivity.

A review of previous studies on productivity identified several factors that can determine productivity levels and which should be taken into account in productivity measurement and benchmarks. These are: ownership and management of hotel; size;

age and design of property; range and type of facilities and services; demand levels; service and operation procedures, e.g. use of ICT; and soft factors such as staff motivation, training, management style etc. However, previous studies in productivity measurement are limited in terms that they focus on isolated factors, e.g. ARR, RevPAR, overbooking, demand levels, and their impact on productivity, ignoring other productivity metrics that can affect their results as well as other external factors that can affect productivity. The need for managerial methods to enhance productivity is so apparent.

In the final analysis, it remains open to question whether productivity measurement is actually practicable in the hospitality industry. Lee-Ross and Ingold (1994) reject it as irrelevant, at least for small – to medium-sized hospitality business. Yeoman et al (1996) consider that productivity measurement may be relevant for certain types of operation; they quote large, three star hotels and budget hotels as appropriate examples. Witt and Witt (1989) believe that a major culture change is required among hospitality managers before they will adopt the measurement-oriented attitudes and hence techniques needed to monitor productivity. In contrast, Jones and Hall (1996) believe that current notions of productivity belong to a manufacturing paradigm, which is irrelevant to the needs of the hospitality industry. They rejected the "new service paradigm", which is irrelevant to the needs of the hospitality industry and urged the adoption of a "neo-service" paradigm in which a new concept, "servicity" replaces that of productivity. However, an approach to measuring "servicity" has not yet been constructed.

2.6 Summary

As it is made evident that productivity definition affects the way productivity is measured and improved, the productivity measurement in this study followed the following working definition of productivity that includes all its previous identified dimensions, e.g. efficiency, effectiveness, quality, profitability and performance. That is based on a total factor perspective that is interpreted in order to include the following: a) all factors of production in order to consider the ICT productivity effect on all factors as well as incorporate the synergy between resources; b) quality and efficiency aspects; and c) other factors that could have affected productivity (e.g. demand, market segment served), but only those that the DEA stepwise approach to productivity measurement found to affect productivity were finally included in productivity measurement.

In this vein, as regards the theoretical underpinning on which this study is based, it is evident that the study draws from all identified theories that are involved with productivity or its dimensions. However, a recently developed theory in the operations management literature has managed to unify all these perspectives and construct a well understood and accepted theory that explains the productivity concept and differences. That is the theory of performance frontiers and this study is founded on its theoretical underpinnings. However, this is analysed in more details in the following chapter.

More specific issues that should be taken into consideration when measuring productivity and the way in which they are addressed in this study are as follows.

- **Determination of the unit of analysis;** the level at which productivity is measured should be specified, i.e. organisation productivity, departmental productivity, process, individual or resource productivity etc.
  The unit of analysis of this study is the whole hotel property, i.e. productivity at the organisational level, which meant that inputs and outputs were measured at an organisational level. In the same vein, ICT metrics, e.g. investment in systems and tools, configuration and ICT use, were also considered at the same level, i.e. the organisational level, in order to allow comparisons (Brynjolfsson, 1993).
  However, productivity metrics are also calculated both at the organisational and at rooms and F&B department level in order to investigate the factors that may affect productivity as well as the ICT productivity impact both at the two divisions as well as at the organisational level. Moreover, because aggregated metrics of inputs/outputs may hinder and obscure the productivity effect of particular items, the hotel overall productivity metric was not developed by applying the stepwise DEA based on inputs/outputs measured at the hotel level, but instead it was constructed based on the factors found to affect productivity by applying the stepwise approach to each of the two departments separately. In other words, the metric of hotel overall productivity is constructed based on inputs/outputs disaggregated at departmental level and not on aggregate inputs/outputs identified at the organisational level that can obscure productivity effects.
- **Determination of the inputs and outputs to be included**; e.g. inputs regarding resources, outputs in terms of end results or intermediate outputs as well as whether factors external to the production system are going to be considered as well, e.g. competition. However, it is not possible that any measurement can take into account of all factors as well as its interpretation would have been difficult.
  As the working definition of productivity adopted in this study is based on a total factor approach to productivity, it is evident that all factors and resources affecting productivity should be considered. Indeed, all input and output factors were included as well as hotel factors that can influence productivity (i.e. market segment served) and an environmental factor (i.e. demand variability). However, although, the process of productivity measurement took into account all potential inputs and outputs that could have affected productivity, at the end only those that the stepwise DEA approach found to affect productivity were included in productivity scores. In this way, productivity measurement and benchmark reflected only factors that affected it, while it did not ignore factors that could have affected its results.
- **Determination whether metrics of inputs and outputs would measure both intangible and tangible features of the input/outputs.**
  As the study followed a total factor approach to productivity reflecting both qualitative and quantitative aspects, the metrics of inputs and outputs used in the productivity measurement process reflected both physical and financial units. However, which of these were included in productivity scores depended on which affected productivity levels as indicated by the stepwise DEA technique.
- **Determination of the function that will reflect the relationship between inputs and outputs.**
  Because of the several limitations of previous techniques and the advantages of DEA for productivity measurement, the study adopted DEA for its productivity measurement. However, a particular approach to DEA was also used called as stepwise approach to DEA. The latter as well as more details on the use and advantages of DEA are given in the following chapter.

CHAPTER THREE

Productivity improvement

In order to understand how ICT can impact and improve productivity, it is required that techniques, theories and models explaining how productivity can be changed are understood. Thus, it is the aim of this chapter to review the literature in order to examine how productivity improvements and/or differences can be achieved. As in chapter two, it is evident that the perspective from which authors perceive productivity affects their approaches and explanations to productivity improvement. Arguments are given from several perspectives, but the chapter ends by analysing a framework and theory of operations management that unifies a number of different views.

3.1 Approaches and ways for improving productivity

As was previously argued the definition and conceptualisation of productivity directly affects productivity measurement, which in turn can have significant impact on staff behaviour and actions on productivity management and improvement. Pickworth (1987) argued that because productivity has been the focus of researchers with different theoretical backgrounds, three different perspectives of productivity management and improvement can be identified, namely the economic, the management science and the behavioural science perspective.

The economic perspective has been concerned with the efficient work of an operation system. It has tended to focus at the macro level and be largely concerned with measurement issues (see for example NIESR, 1989 and NEDC, 1992).

The management science approach has been based on the application and further sophistication of industrial-engineering techniques for improving operational efficiency. A wide range of productivity measures, e.g. customers served per employee and sales per employee, that are strictly focused on efficiency, reflect such work (see for instance, Ball, 1992). However, Pickworth (1987) argued that managers should broaden their conception of productivity to include the dimension of effectiveness as well. The rationale is that productivity has to be viewed from a strategic as well as a tactical perspective meaning that management must concern itself with how well objectives have been identified and resources deployed and not just how well an operation converts inputs into outputs.

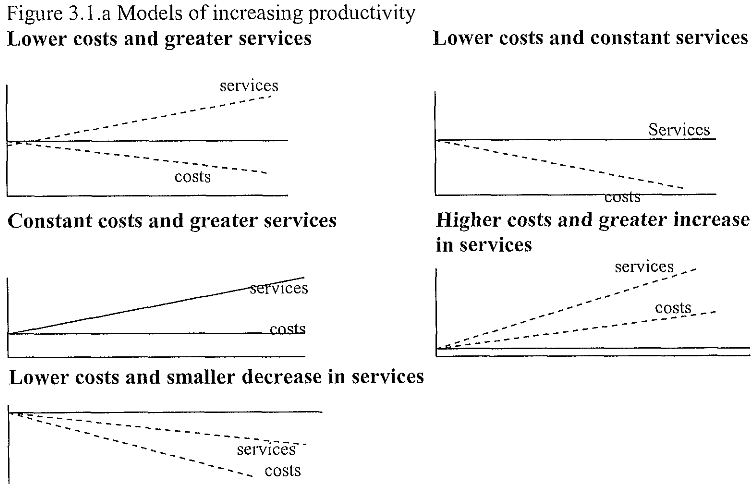
Behavioural scientists have generally defined productivity in the broadest of terms and so, extended the existing notions of improving productivity in two directions (Pickworth, 1987). First, productivity improvement should be viewed from a strategic, proactive perspective as well as from a tactical, reactive perspective. Second, productivity improvement should be both technique-oriented and focused on changing corporate culture (see for instance, Clark, 1994 and Brown and Dev, 1999). In particular, their approach to productivity improvement is related to improving employee performance while paying less attention to measurement issues. The emphasis is on assessing the significance of the various factors that influence productivity, that go further than improving working conditions and time-and-motion studies and concern employees' level of motivation and capabilities, because regardless of how well the service delivery system is designed, demoralised employees cannot achieve optimum productivity. However, the applicability of behavioural techniques, e.g. quality circles and incentive schemes, are very situational specific. Behavioural scientists also strongly support that productivity improvements are a result or at least significantly related to corporate culture. Because changing an organisational' s culture implies more than changing structure and processes, from a behavioural scientist's approach, productivity improvement is seen as a process of social change, in which the input is expectations and the output is satisfaction.

Gummesson (1998) also identified the different perspectives to productivity management and improvement. He (1998) argued that "the triples at play", i.e. productivity, quality and profitability, are all concerned with the same organisational performance, but from different perspectives and so, they have given rise to three "tribes" within organisations, namely, the productivity tribe, the quality tribe and the accounting tribe, each one representing different traditions and culture. The productivity tribe may consist of engineers, statisticians, accountants or economists that are cost-obsessed and devoted to internal operations. The quality tribe used to be internally oriented but has lately changed direction towards revenue and customer satisfaction and the accounting tribe are dedicated to measurement of short term and historical data.

By conceptualising and measuring productivity as a ratio of inputs and outputs, Jones (1988) and Sandler (1982) identified five alternative ways of improving the productivity ratio (Figure 3.1.a):

1. decrease inputs/decrease output proportionately less; this option assumes that a cost reduction exercise will have some impact on output, but that the fall in output will be more than offset by the savings made. This approach is known as paring down.
2. decrease input/hold output constant; this option identifies circumstances where existing provision is inefficient – that is to say corrective action should be taken by changing the inputs to achieve the same level of output but at lower cost. In effect this is a special case of "cost-cutting". In reality, as we have seen from chapter two, holding inputs constant is difficult to do. This approach is known as cost reduction.
3. increase inputs/increase output proportionately more; this is a market oriented approach, which recognises that the change in output can only be achieved at some extra cost. This is known as managing growth.
4. hold inputs constant/increase output; this option also implies inefficiency, in that the same inputs could produce more output. This option is known as working smarter.
5. decrease inputs/increase output; this option is possible, but is likely to occur infrequently. It usually arises with the introduction of new ICT and/or the redesign of processes. This approach is known as innovation.

Figure 3.1.a Models of increasing productivity



Source: Merricks and Jones (1987)

All these ways aim at the same goal (Sandler, 1982): a) increasing the area between outputs and inputs; b) or get more out of what one put in. However, cases two and four are considered as "special" cases, because according to systems theory it is very difficult to hold one variable as constant (input or output) whilst changing the other. Overall though, as these cases reveal different ways of approaching the productivity concept, they are valuable in clarifying the possibilities that may exist or that can be created, and especially in indicating the broad mix of hotel products.

However, Mudie and Cottam (1992) pointed out that whatever way is selected the true test will be the effect on the quality of the service. Johns and Wheeler (1991) also argued that strategies for increasing productivity must take account of qualitative issues, because productivity improvements indicated by quantity measures such as rooms occupancy and number of covers sold tend to be poor estimates as increased output may strain resources so that quality falls. Hence, Johns and Wheeler (1991) summarised the previous five ways and extended them to include quality by identifying two distinct types of management strategy for raising productivity:

1. Volume, and/or quality can be increased, while reducing, holding constant or only raising slightly the level of resource used. In effect, the strategy aims to increase the upper (outputs) term of the productivity equation, whilst holding the lower (inputs) term constant. To that end, an increase in demand and sales is aimed through aggressive marketing techniques, e.g. promotion, and improvements in product development, image, quality and market share without a proportional increase in resources. Strategies aimed at maximising revenue in this way are referred to as expansive strategies.
2. Resources can be decreased while the volume and/or quality are decreased slightly, held constant or increased. These strategies emphasize the lower (inputs) term of the productivity equation and are commonly associated with productivity management in the manufacturing sector. Thus, they involve careful analysis of costs and profitability, with cutbacks in material, energy and labour wherever possible. Strategies seeking primarily to cut costs are referred to as contractive strategies.

In other words, market orientation relates to the top half of the productivity equation and cost control to the denominator. Johns and Wheeler (1991) have though recognised that because of being in the service sector and operating in highly competitive circumstances hospitality executives have focused on the revenue rather than the cost side of the business.

In considering the specific features of the hospitality product and specifically the service encounter, e.g. time, place and quality, Jones (1988) proposed an innovative way of managing and improving productivity. According to his approach, productivity improvement requires the management of four concepts, i.e. efficiency 1 (production process), efficiency 2 (service/product provision process), capacity (customer take-up) and quality management, but each one may require different techniques. Many authors have previously recognised the impact of these concepts on productivity, however nobody had so far attempted to illustrate and link their interrelationships. So, Mill (1988) argued that productivity measures in services tend to measure both the ability of the operation to produce and sell the service, but she did not suggest how these different issues should be measured. Nonetheless, he pointed out these two factors as being two major influences of productivity levels. Baker and Riley (1994) also highlighted demand forecasting, adjustment of manpower resources to demand levels as crucial factors to productivity. Armistead et al (1988) argued that service managers should control all three main influences on productivity: a) the input costs; b) the transformation of these resources into outputs (efficiency 1); c) what they call utilisation of these transforming resources (or capacity management), which involves not only maximising the utilisation of the total operating system, but also of the operating sub-systems.

Several specific ways for achieving these strategies are found in the literature. For example, Lovelock and Young (1979) identified four ways by which a service firm can increase productivity:

- improve the quality of its employees through better recruitment and training;
- invest in more efficient capital equipment (state-of-the-art technology for sales, service, distribution etc)
- replace workers with automated systems (e.g. replace receptionist with voice mail, replace sales department with online reservations)
- recruit customers to assist in the service process (e.g. replace receptionist with automated check in machines)

Haynes and Huffman (1985) reviewed analytical techniques for identifying the most profitable menu items, while Lockwood and Jones (1989) described a similar approach for room tariff rates. Milson and Kirk (1979) reviewed the following contractive techniques of productivity management, which are significantly facilitated or developed through the use of IT:

- Reorganisation of facilities, such as the application of manufacturing techniques, e.g. production line methods, centralisation of activities, self-service operations.
- Scheduling, i.e. the identification and matching of the staff and equipment availability with the required output;
- Ergonomic analysis, which involves the analysis of personnel movement which is coupled with subsequent workplace redesign aimed at economy of motion;
- Work study, which involves the timing and tasks in order to identify their labour content and cost and can aid in scheduling or layout planning and it can also be used to assess the potential value of mechanisation or automation;
- Mechanisation, which involves replacing operations by mechanical ones. Deskilling is an effect of mechanisation and so labour costs are reduced because less but also cheaper work force is required and less training is to be provided.

However, while cost control and cutting exercises have taken place within many hotels, the marketing mentality has usually prevailed as the means for achieving the hotel productivity goal (Geller, 1985). Kotas (1975) had earlier argued that the most important determinants of hotel and catering profitability are on the revenue side of the business by increasing volume and/or quality. However, as volume is usually limited, e.g. occupancy rates have a fixed ceiling at 100%, productivity improvements have also top limits. On the contrary, unlimited productivity improvements are provided by improving the quality of the tangible product or by improving the quality of service. In improving service quality, Martin (1986) argued that two factors should be considered namely service procedures and staff conviviality.

Indeed, in investigating the most important goals and critical success factors (CSFs) of 27 US hotel companies, Geller (1985) found that expansive strategies are readily accepted in the hospitality industry and are particularly suited to the market-oriented outlook of managers. On the other hand, "cost control" was placed well down the Geller's list of CSFs and not related to productivity management per se. Johns and Wheeler (1991) though commented that contractive, cost control tactics can offer the industry possibilities for progress in productivity, clearly because they are not currently given priority.

Contractive strategies are viewed as synonymous with manufacturing techniques, but the applicability and adoption of productivity management techniques from the manufacturing industry have been studied by several researchers. Moreover, although, the majority of these techniques is covered by operations management texts and is only geared to non-service situations, there are cases were manufacturing oriented authors have also referred to the service sector. So, Meredith (1989) and Schroeder (1985) incorporated applications to and examples from the service sector, while Fitzsimmons and Sullivan (1982) have written specifically for service operations.

In the service industry literature, Levitt (1972) claimed that the total service delivery system might be looked at as production line by providing several examples such as the fast food sector, automated bank tellers and self-service stores. This industrialisation or technocratisation of service can be achieved by using "hard" technologies, such as automatic vending machines, or "soft technologies", which focus on people and systems in operation and has a direct effect on the standardisation of the output of the service delivery process. The aim is though to increase efficiency in resource utilisation and eliminate the negative effects of demand variations, i.e. underuse or overuse of resources. Thus, traditional craft-based kitchen and restaurant operations (the manufacturing equivalent of job-shops) can be turned into batch process or mass production systems. The impact of this is to standardise the output of the service delivery system.

Jones (1979) and Heizer (1981) showed how inventory management skills may be transferred from manufacturing to service. Jones (1979) illustrated the use of Material Requirements Planning (MRP) in a snack bar at a US college. Heizer (1981) discusses the use of computers to help control inventory and gives an example where excessive usage of cooking oil was identified though the use of a technique analogues to inventory management techniques used in manufacturing industries which eventually led to the identification of a malfunctioning thermostat. Meredith (1989) illustrated the use of Just-In-time (JIT) in "The 100 Yen Sushi House", that involved food delivery several times a day in order to reduce the need for refrigeration capacity, minimise inventory and cost and guarantee freshness of the Sushi.

Jones (1986) identified eight different scenarios of catering operations that have applied to the front – and/or back-of-house part of the operation one or more of three trends derived from the manufacturing industry in order to overcome or eliminate the implications that the timing, place and customer participation have on service productivity. These are production-lining, decoupling and increased customer participation.

Both Bateson (1985) and Chase (1981) also investigated approaches involving greater levels of consumer participation in the service experience, both in terms of self-selection and self-service. The major gain derived in terms of productivity is that the consumer himself/herself carries out operations usually provided by staff, meaning that the consumer undertakes some of the production tasks. Quality is also argued to enhance in consumers' perceptions, because he/she can select from several items.

In reviewing more suggestions for the use of operations management techniques in the hotel sector made by various authors, Witt and Witt (1989) argued that whilst not all the answers to the productivity in the hotel industry will be found in the manufacturing sector, there exist appropriate techniques which do not appear to be used by hotel management. Fitzimons and Sullivan (1982) also pointed out that the transfer of manufacturing technology in the hospitality industry, such as inventory control systems and techniques for process analysis, can substantially increase productivity. This does not though suggest that all the answers to the productivity problem in the hotel sector are to be found in the manufacturing sector. However, as Fitzsimmons and Sullivan (1982) argued a simple adoption of product-oriented operations management techniques to a people oriented endeavour is not adequate, but this should not lead to the misconception that service organisations are so unique as to be immune to the application of knowledge gained in the manufacturing sector.

Indeed, despite the widely argued applicability of manufacturing techniques in the hospitality industry a debate exists in terms of whether and when both contractive and expansive strategies should be applied in the hospitality industry. So, various authors argued that contractive strategies are not appropriate for increasing productivity in the hospitality industry. Kotas (1975) pointed out that because of the high capital intensity and perishability of the hospitality product, the industry should adopt market-oriented operating strategies and above all be responsive to market needs. Moreover, he (1975) supported that the higher the price and average spend within a sector, the more important marketing orientation becomes. In replying to arguments that labour expenditure is also a substantial cost for hotels and so, strategies are needed to reduce it, Kotas (1975) argued that time spent on making such reductions would be better employed on marketing.

Johns and Edwards (1994) advocated that contractive strategies run the risk of successively reducing product quality, which in turn decreases the revenue-earning potential and so, a cycle is produced in which decreasing revenue demands further cost-cutting. This damages product quality still more, so that the business spirals downwards through an ever-tightening vicious circle, which Pickworth (1987) called the "productivity trap".

The trade off that seems to exist between productivity and quality is mainly due to the fact that productivity has so far been defined and measured by a narrow efficiency scope. For example, Witt and Witt (1989) argued that labour productivity in terms of "covers" (i.e. a physical metric not including effectiveness) is lower as quality rises and the reverse may also occur. However, the provision of better service implies more sales revenue (i.e. higher prices, repeat business) and so, if productivity is measured by an aggregate financial metric, e.g. sales revenue, the trade off between productivity and quality disappears. Indeed, as Butterfield (1987) found over 80 per cent of today's business leaders recognise the positive correlation between quality and productivity.

According to Jones (1988) the inherent diversity of most hospitality operations compared with those found in manufacturing industry is a major difficulty in the adoption of manufacturing techniques. In this vein he (1988) argued that the type of contractive strategies found in the manufacturing sector are only appropriate for back-of-house operations, e.g. food production or laundry, while expansive strategies should be applied to front-of house management.

Johns and Edwards (1994) also argued that different production systems require different productivity improvement approaches. Specifically, contractive strategies appeared most suitable for managing the "production" aspects of hospitality operations, e.g. rooms' servicing and food preparation. This is because these functions generally take place out of sight of the customer, who receives only the tangible evidence that the task has been done and so they offer the greatest scope for cost cutting through operationalising the work. To that end, the following techniques were proposed: scheduling, control and rationalisation of tasks, replacement of operatives by machines, which in turn may lead to de-skilling of jobs, i.e. utilisation of fewer and less skilled staff. Expansive strategies were argued appropriate for improving the productivity of "service" operations, because as these operations generally take place in full view of the customer, it is often inappropriate to standardise, modify or depersonalise the encounter. In this case, it may be possible to do some staff reduction but the effective way to improve productivity is to increase the revenue-earning potential of the service encounter itself, so that more income is generated by the same complement of staff. For example, by enhancing the selling skills of front office staff productivity will increase both in terms of actual sales made and in terms of customer perceived quality.

Chase (1978) also advocated the idea of isolating the technical core of the service business, so that efficiency could be improved in the non-contact part of the provision. Specifically, service industries characterised as "low-contact" are argued as most suitable, because the technical core can then be set up to operate continuously irrespective of short-term changes in consumer demand.

Some other authors considered the adoption of either market or cost strategies as too limited an approach to hotel productivity. According to Ball et al (1986) hotels should accept that a reciprocal relationship exists between demand and supply, inputs and outputs, market strategies and cost strategies. For example, it would be little value in pursuing marketing strategies to increase businesses within hotels during slack periods if the workforce were too inefficient to cope. And vice versa, there would be no point improving systems of working and increasing staff flexibility, if customer demand was not present. Hence it is evident that in order for hotels to be managed within a productivity framework they would need to square up to the market (output) and resource (input) aspects synergistically.

Recognising that operating systems in the service sector, and particularly in hospitality organisations, tend to be complex combinations of both "production" and "service" operations, Staw (1986 and 1987) also argued the integration/combination of contractive and expansive strategies. He (1986 and 1987) proposed three approaches to the integration of productivity initiatives:

- individually-oriented systems whereby the individual is the focus of productivity his contribution is aimed to be maximised by individual targets, rewards and other motivating factors;
- group-oriented systems put the group (department or team) in the centre by developing team loyalty, using group rewards, training and motivating teams as discrete entities;
- organisational-oriented systems aimed at enhancing organisational productivity by promoting a culture of belonging, e.g. by removing status distinctions between employees, profit sharing schemes.

By understanding that the main focus of application of manufacturing techniques is on back-of-house operations such as food production and laundry, Witt and Witt (1989) claimed that contractive techniques seem to work against team building, since their application tends to isolate the back-of-house functions from other aspects of hospitality in ways which may be physical or cultural or both. In turn, physical isolation at another site may cause management problems, while cultural isolation may result from the difference in modus operandi between back- and front-of-house operations or from the psychological effects of merchandising, deskilling etc. Because of that, Johns and Wheeler (1991) argued that the development of productivity management along these divergent lines between departments and systems may lead to the development of an increasingly diverse workforce as well as to tension and frustration. They (1991) so proposed a different approach to productivity improvement involving the review and redefinition of hospitality staff roles, which could also reduce tension between the two productivity management strategies. This is described as follows.

Sasser and Arbeit (1976) distinguished staff between "first line" (those that have direct contact with the customer) and the "second line" (those who do not) with the rationale that since people will remain services' essential ingredient for the relevant future, the one indispensable feature of the hospitality industry is the face-to-face contact with the guest. If their view is adopted, then a contractive view of productivity could involve the reduction of as many "second line" personnel as possible, e.g. by automation, outsourcing, centralisation, while an expansive approach would aim productivity improvements through the engagement of second line staff in first line roles. Gummesson (1988) and Johns and Wheeler (1991) recognised the need of all staff to sell to customers by arguing that all staff should become part-time marketers.

Johns and Wheeler (1991) also described ways of how an expansive internal marketing can be used in order to redefine front-of-house and back-of-house staff's roles in order to augment productivity. Efficiencies were also claimed to be gained by eliminating functions from second-line staff. Overall, they (1991) suggested the application of contractive strategies for the non-value added aspects of "second line" work and of expansive strategies for the value-added aspects of "front-line" work.

In fact, approaches to productivity improvement toward redefinition of staff roles are similar to Business Process Reengineering (BPR) and Business Process Improvement (BPI) initiatives that aim at enhancing productivity by reviewing business processes, eliminating unnecessary functions and non-value work, streamlining procedures, integrating back- and front- office functions and changing operations, structures, information gathering and dissemination from a product oriented to a customer centric approach that puts customer service, quality and satisfaction first (e.g. Hammer and Chammer, 1993; Davenport, 1993). Because BPR and BPI are very ICT dependent or fostered (although they can also be undertaken without any ICT change as well), they are analysed in detail in the section discussing the impact of ICT on productivity.

However, whatever the approach or its definition the rationale of productivity improvement is the same, i.e. eliminate waste, slack resources/unused resources, increase revenue while minimise the effect of demand variability and variety. Moreover, the selection of the approach to productivity improvement is argued to be dependent on organisational factors, such as organisational strategy and response to environmental factors, which is analysed in the following.

3.2 Factors affecting the approach to productivity improvement; the relationship between productivity improvement, organisational and operations strategy

Crandall and Wooton (1978) argued that productivity interpretations, strategies and actions relate to the development of an organisation. Johns and Wheeler (1991) also recognised that the stage at which an industry is has a bearing on the appropriateness of productivity management strategies. Ball (1996) argued in addition that productivity measures and controls should change to something more appropriate as priorities alter, because if measures are not reviewed the productivity focus may not have any relationship to currently important issues and patterns of behaviour may become rigid. Continuous review and change of productivity metrics is also recognised by Mohanty and Rastoni (1985) and Thorpe (1986), who advocated that productivity improvement should be a dynamic process in order to ensure that patterns of behaviour change according to currently important issues. They (1985 and 1986) also highlighted that productivity can be perceived in strategic terms.

To illustrate how strategic factors and approaches to productivity improvement differ depending on the cycle of development that has been reached, Ross (1981), Sandler (1982) and Jones and Lockwood (1989) developed the following model (Table 3.2.a). This referred to a fast food chain illustrating how strategic approaches are translated into input and output changes. Ball's (1996) study validated the face reliability of this model, since it was overall found that productivity has strategic dimensions and that different people have different perspectives of productivity according to the phase of development they believe the chain, or an individual restaurant, is in.

Table 3.2.a Organisational life cycle and productivity strategies

PRODUCTIVITY STRATEGY	**WORKING EFFECTIVELY**	**WORKING SMARTER**	**MANAGING GROWTH**	**COST REDUCTION**	**PARING DOWN**
Input/output change for greater productivity	Increase output, decrease input	Increase output, maintain input	Increase Output > Increased input	Decrease Input, Maintain Output	Decrease output < Decrease input
STAGE OF THE SERVICE LIFE-CYCLE	**INNOVATION**	**DEVELOPMENT**	**GROWTH**	**MATURITY**	**DECLINE**
Main firm features at each stage Main operation features at each stage	Slow growth, one or two prototype operations Trying out new ideas by trial and error	Growth by opening new outlets Adopt model, trial elsewhere	Vary rapid geographic growth Adapt slightly in new locations	Saturation of sites Adapt greatly to meet competitive threats	Close down less profitable units Revamp completely

Source: Ball (1996)

Olsen and Connolly (2000) recognised that environmental variables such as the aging of the workforce and the sophistication of consumers have contributed significantly to the maturing of the hotel industry. According to Johns and Wheeler (1991) in the maturing hospitality industry, marketing strategies will become less and less efficient means of promoting productivity, while business performance will increasingly depend on monitoring the revenue/cost ratio and on achieving more from fewer resources, which will inevitably involve reorganisation, redesign of facilities, self-service, better scheduling etc- many of the tactics used by the manufacturing sector. The industry will also need simultaneously to maintain and strengthen its work in team building and internal marketing. However, considering that productivity is a ratio of inputs and outputs and so that both the numerator and denominator should be considered, they (1991) argued that a combination of expansive and contractive strategies will be required.

The work of these and other authors (e.g. Ball and Johnson, 1989) analysed to some extent the complex interaction between productivity and the longer-term strategic concerns of business. Edgar's (1996) study provided evidence of the impact of both strategy formulation and strategy implementation on hotel productivity. Brown and Dev's (1999) study provided evidence of the impact of choices in strategic decisions on productivity. In particularly, they (1999) proposed and found that choices on hotel's service orientation, ownership arrangement, management arrangement affect both labour and capital productivity. On the contrary, no effect of strategic orientation was found on either indices of productivity.

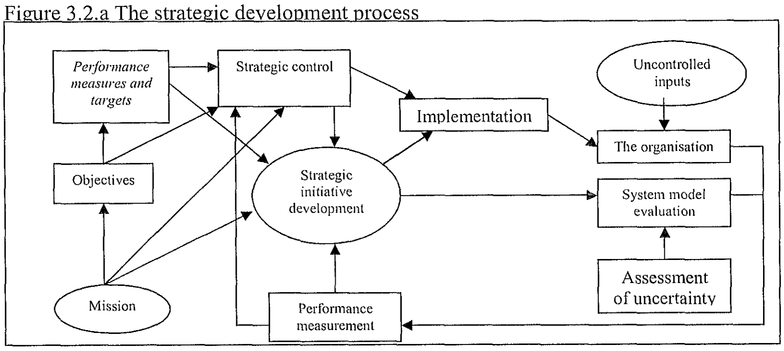
The productivity strategy relationship has been argued to be bi-directional and so arguments indicating the impact of operations decisions on strategy also exist. One attempt worth mentioning to illustrate how operations can support and help strategy and enhanced performance is that of Bell (1998). Bell (1998) advocated the term strategic operations research, which might be thought as competitive business process engineering. Bell illustrated how major operations research (OR) practices in leading-edge organisations have led to sustainable competitive advantage over a significant period of time and enhanced performance, which made him argue that they can be reasonably labelled as strategic OR. He (1998) used the following examples: airline crew scheduling (American Airlines, whereby major advances were made in the efficiency and effectiveness of the deployment of a $1.3 billion budget); yield management (American Airlines and National Car Rental); optimal siteing of telemarketing centres (AT&T); and help in attaining corporate goals and strategies (San Miguel). Although the performance impact of such process engineering practices is undeniable their sustainable competitive advantage is debated according to Porter's (1980) argument - that such developments are essentially mimicable by competitors and so advantage cannot be long run.

The reciprocal relationship between operational research (OR), performance measurement and strategy is also advocated by Dyson (2000). In reviewing the literature, she (2000) illustrated and argued how operational research is well fitted to handle strategic issues because the modelling approach of OR facilitates understanding and learning and the evaluation of strategies prior to action. To illustrate her arguments she provided a working definition of OR as follows:

"OR is concerned with models, methods, methodologies, problem structuring, analysis and facilitation for the advancement of tactical and strategic organisational decision making" (Dyson, 2000, p. 5)

She (2000) also developed a strategic process model that integrates performance control systems, strategy development systems and operations systems together (Figure 3.2.a). A strategy is expressed in mission, objectives which are implemented through operational initiatives and controlled by measurement systems and targets. Moreover, a feedback loop of measurement systems provides necessary information for the adjustment of strategic objectives and the improvement of their implementation. The model also highlights the importance of performance measurement through the influence of performance measures and targets on the behaviour of the organisation and in particular its influence on the development of new strategies.

Figure 3.2.a The strategic development process

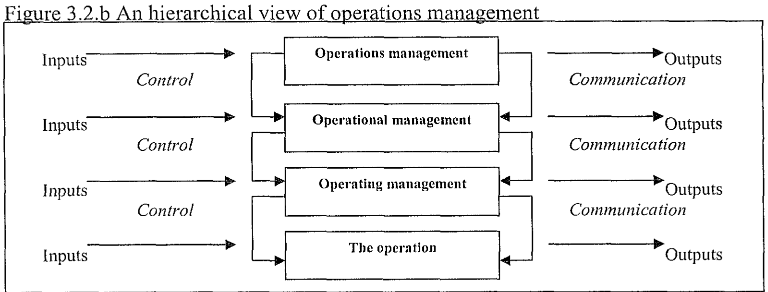


Source: Dyson (2000)

In the context of hospitality operations, Jones and Lockwood (1995) had earlier argued the relationship between strategy, operations management and performance measurement. Actually, they (1995) provided a greater level of analysis by providing examples of the activities and issues that each concept implies for hospitality management. After reviewing different systems modelling approaches and arguing their relevance to hospitality operations, Jones and Lockwood (1995) applied systems theory to illustrate their arguments by developing a four level hospitality system framework (Figure 3.2.b).

Jones (1995, p. 20) argued that *"successful operations are those where there is a good fit between all four levels and between the inputs, processes and outputs at each level"*, which reflects the arguments regarding the relationship between strategy and operations practices as well as the required alignment between strategy, organisational structure and IT resources strategy and configuration if productivity benefits are to materialise (Henderson and Venkatraman, 1989).

Figure 3.2.b An hierarchical view of operations management



Source: Jones and Lockwood (1995)

Each level has distinctive characteristics and allows the identification and understanding of different management activities. Operations management is at the higher strategic level concerned with relating the organisation to its environment and designing comprehensive systems and plans (similar to the strategy development of Dyson's model). Three levels of OR as argued by Dyson (2000) are identified by Jones and Lockwood (1995). The operational management system (level two), is concerned with integrating different parts of the operation and thus making sense of an integrated/aligned management of the different key results areas, namely, assets, employees, capacity (or customers), productivity, service, income (or control) and quality. The operating management (level three) is responsible for the day-to-day management of the operation, delivery of predetermined products/services and maintenance of operating standards. Environmental impact at this level is very limited. The operation (level 4) involves technology and its successful application by users, i.e. front and back of house employees as well as customers.

Along with the principles of hierarchy, Jones and Lockwood (1995) suggested the principle of communication and control that stresses the importance of information flows between levels and the control actions in order to maintain balance of the operation with its external environment. Both control as a provision of guidance and constraints imposed on operations by previous level decisions allow a more effective assessment and understanding of performance. In this vein, control and communication are similar to the concepts of performance measurement and feedback loop in Dyson's (2000) model.

New approaches to performance measurement, e.g. the balanced scorecard, also try to reflect the relationship between strategy, performance measurement and operations as they are mission/strategy driven and try to measure and illustrate the effect of operations activities, e.g. business processes on final financial metrics (Dyson, 2000). Later, the term "strategic operations" was also used by Jones (1999b) to indicate operation practices at strategic level that can have a significant impact on hotel performance. Specifically, he (1999b) identified seven interrelated activities that will be important in this millennium, of which technology and "hard systems" was one.

The benefits of the systemic model to hospitality operations management for examining operations issues and specifically for productivity measurement and control are highlighted by Jones and Lockwood (1995). They (1995, p. 20) argued that *"this approach aids in thinking about all kinds of operations management problems, for instance, the productivity of hospitality operations, where a systems approach may identify issues relating to what to measure and how to measure it"* and continued by arguing that *"...some of the confusion is because there is a lack of clarity about what level of productivity is being measured, and hence what are the appropriate inputs and outputs to measure".*

In this vein, the hospitality operations system can also be used for identifying and explaining differences in productivity performance. A bad hotel performance may be due to one or a combination of four reasons (Jones and Lockwood, 1995): a) the basic concept, the overall design of the service package may not work, i.e. wrong actions at the strategic level; b) the operational systems are not appropriate for the concept, i.e. a failure of the operational management; c) expected standards of performance are not met by management, i.e. failure of operating system; and d) a breakdown in the equipment or system, i.e. an operation's failure.

3.3 An operations management theory explaining productivity differences

As the previous analysis indicated, there is not any generally accepted theory of operations management. Indeed, the field of operations management has been criticized for the inadequacy of its theory (Swamidas and Newell, 1987; Anderson et al, 1989; Flynn et al, 1990; Swink and Way, 1995). As Schmenner and Swink (1998) argued operations management although recognized as vital to the prospects of any company, it suffers in at least some quarters because there is no recognised theory on which it rests or for which it is famous. Hence, they (1998) went on to develop two theories namely, the Theory of Swift, Even Flow and the Theory of Performance Frontiers. The first explains cross-factory productivity differences and the second addresses the broader measures of across-factory performance. These two theories are not in conflict but complementary. The theories also illustrated how existing knowledge in operations management can be fashioned into theory as they refined and unified existing theories or laws as well as proposed several other testable hypotheses. The two theories also meet criteria required for the scientific inquiry in general terms (e.g. Hempel, 1965; Bacharach, 1989). They also fill the theoretical void in the operations management literature by providing grounding for its policy implications (Shmenner and Sink, 1998). They do so because:

- The operations management phenomenon for which explanation is sought should be clearly defined. This clarity is enhanced by unambiguous measures of the phenomenon.
- The description of the phenomenon will likely center on some observed regularities that have been derived either logically or empirically.
- There should be one or more precise statements of these regularities (laws). Mathematical statements of the laws will naturally help the precision.
- The theory should indicate a mechanism or tell a story that explains why the laws may be subject to limitations. The theory may include some special terms or concepts that aid the explanation.
- The more powerful the theory, the more likely it will unify various laws and also generate predictions or implications that can be tested with data. Furthermore, the power of the theory does not necessarily rest with the methodological choice of the tests made.

3.3.1 The Theory of Swift, Even Flow

According to this theory the more swift and even the flow of materials through a process, the more productive that process is. Thus, productivity for any process – be it labour productivity, machine productivity, material productivity or total factor productivity – rises with the speed by which materials flow through the process, and it falls with increases in the variability associated with the flow, be that variability associated with the demand on the process or with steps in the process itself (Schmenner and Swift, 1998). In other words, the Theory of Swift and Even Flow explains how productivity in strict terms (i.e. efficiency) can be improved.

The concept of value and non-value added work further explains the theory of Swift, Even Flow. Value added work is regarded as that transforming materials into good product, while work that moves materials, catalogues them, inspects them, counts them, or reworks them is regarded as non-value added. In other words, anything that adds waste to the process is non-value added. This relates to the classic seven wastes of Shigeo Shingo namely, overproduction, waiting, transportation, unnecessary processing steps, stocks, motion and defects (Hall, 1987). In this vein, materials can move more swiftly through a process if the non-value added, wasteful steps of the process, are either eliminated or greatly reduced.

By looking at what flows through the operation process, Slack et al (1995) identified three basic types of operations, namely materials processing operation (MPO), customer processing operation (CPO) and information processing operation (IPO). However, in most cases no operation is uniquely MPO, CPO or IPO, but a combination of these three and this is definitely true for the hospitality operations (Jones, 2000). In this vein, the Theory of Swift and Even Flow should be extended to all transformed resources apart from materials, i.e. information, customers and other resources applicable in the hotel sector. Thus, wasteful steps and non-value added work could be the re-entering of data into systems, delays in handling customers enquiries due to lack of systems integrations that inhibits data access to all staff, or over and under bookings due to inefficient control of room inventory.

Methods under the Scientific Management movement were proved to be able to improve labour productivity (i.e. output per worker-hour of labour). So, scientific methods aimed at removing non-value added motions and steps from what labour does, speeding up value-added steps and so, the flow of materials, but putting more physical stress on the workforce. However, scientific methods make little difference, according to the theory, when applied to non-value added work. One should thus expect to see varying success with scientific methods depending upon the steps in the process to which they are applied; their biggest impact is expected on bottleneck operations.

In fact, the Theory of Swift, Even Flow unifies the generally accepted concepts of variability, bottlenecks, scientific methods, quality and factory focus, while it is also consistent with and also augments microeconomic theory. Schmenner and Swift (1998) explain how as follows.

Overall, materials can move swiftly only if there are no bottlenecks or other impediments to flow in the way. To capture this, the theory links to another concept, throughput time, i.e. the speed of the flow from the point where materials for a unit of the product are first worked on until that unit is completed and supplied to either the customer or to a finished goods warehouse. Throughput time is particularly useful as a mechanism to isolate where flows have become retarded or blocked. The law of bottlenecks implies that an operation's productivity is improved by eliminating or by better managing its bottlenecks and is associated with Goldratt (1989) "theory of constraints". If a bottleneck cannot be eliminated in some way, say by adding capacity, productivity can be augmented by maintaining consistent production through it, if need be with long runs and few changeovers.

Hence, other things being equal, the theory urges the process to reduce the clock time spent in this way (the throughput time). Research on work study has given detailed insight on how process design can affect productivity. BPR approaches have also shown how the streamlining, restructuring and elimination of non-value added processes can substantially enhance work flow, quality and productivity gains. However, BPR initiatives in contrast to scientific management techniques require a whole review of all processes in order to avoid rationalising work that is non-value added but rather fully eliminate it (Hammer, 1990).

Schmenner and Swift (1998) provided examples of BPR initiatives that illustrate the arguments of the Theory of Swift, Even Flow. Specifically, the theory favours reducing work-in-progress inventories as they can bog down the swift flow of materials and raise throughput times to high levels. It is also very much in tune with the just-in-time manufacturing philosophy and the co-ordination of the supply chain, because the smoother the links and the faster the flow from initial materials to the end customer, the more productive all aspects of the supply chain can be.

Variability implies that the greater the random variability either demanded of the process or inherent in the process itself or in the items processes, the less productive the process is. This law derives from queuing theory and can easily be verified by simulation (Conway et al, 1988). The more variable the timing or the nature of the jobs to be done by the process, and the more variable the processing steps themselves or the items processes, the less output would be from the process, as captured by labour productivity measures, machine productivity measures, material productivity measures or total factor productivity measures.

This is also in line with the previously analysed arguments of Armistead et al. (1988) and Jones (1990) regarding the impact of volume, variety, variation and variability on productivity levels and improvement strategies.

The impact of volume on input costs reflects the traditional economies of scale. In services, these relate in particular to increased purchased power, spreading of central overheads, marketing economies and labour specialisation (Mill, 1988). There are similar influences on the efficient transformation of sources as well as "Learning effects". Furthermore high volumes also allow delivery system to balance so that all subsystems are operating at optimum levels.

The impact of variation of demand requires that services adopt strategies and approaches that enable flexibility. Capacity management strategies, scheduling and forecasting are important productivity management techniques. Blois (1984) also added any strategy aiming at changing the nature of demand as an approach to productivity improvement. Such an approach involves attempts to match demand with capacity more effectively by encouraging customers to undertake some of the work themselves, e.g. decoupling some of the front office operations, production lining and self-service can be included in this approach, as discussed by Jones (1986 and 1988).

However, the concept of variability suggests that not only will total demand vary, but also the demand for the range of services on offer will vary. Fluctuation in sales mix has an impact in sales costs by not only reducing potential economies of scale, but also by making the implementation of strategies designed to cope with variety more difficult and providing additional pressure for accurate forecasting of potential demand. Thus, potential productivity gains derived from high volume may be offset by the level of variety offered.

For resources to flow more evenly, one must narrow the variability associated with either the demand on the process or with the process's operations steps (as emphasised by Riley, 1999). Because variability is measured by the variance or standard deviation of the timing or quantities demanded or of the time spent in various process steps, it can be narrowed when the demands placed on the process are even and regular. Thus, all year operating hotels are more compatible with productivity than highly seasonal hotels. Variability is also narrowed whenever like things are processed together and so, whenever like things are worked on together, without slowing down the process, productivity increases, i.e. specialisation of tasks. For example, Armistead et al (1988) stated that high variety reduces volume per service line and requires specialised plant, equipment and employees, which is likely to reduce the efficiency and make more difficult their full utilisation.

It is also evident that companies focusing on a limited set of tasks will be more productive than similar companies with a broader array of tasks. This is the "focused factory" concept (Skinner, 1974) aiming at reducing variability by grouping products (and less commonly processes) together, because the latter allows the flow of materials for those products to be viewed more easily and naturally and so, permits the identification of bottlenecks and of non-value added steps that should be removed. The theory of swift and even flow also highlights the previously analysed productivity-quality relationship. Productivity can frequently be improved as quality (i.e. conformance to specifications, as valued by customers) is improved and as waste declines, either by changes in product design, or by changes in materials or processing. This is because among the most disruptive things to a process are temporary bottlenecks caused by quality problems that force rework, scrap, machine downtime, interrupted flow of materials etc. Thus, quality is essential to the swift, even flow of resources as it helps both to lower variability and to avoid bottlenecks.

The Theory of Swift, Even Flow also offers a variety of qualifications to microeconomic theory, as it relates to productivity, that do not argue against microeconomic theory but complement it wherever the latter is limited. So, while microeconomic theory argues that substitution of capital for labour will augment labour productivity, the Swift, Even Flow theory argues that higher productivity is only possible when the capital for labour substitution leads to faster, steadier flows. Continuous flow processes are nearly always both more capital intensive than other types of processes and more productive, but the Swift, Even Flow Theory argues that it is not the capital of the continuous flow process that is important to its high productivity, but it is rather the continuous, less variable nature of the flow. In the context of this study the important point here is that it is not ICT investments in themselves that can lead to productivity improvements but it is rather the applications of ICT that can boost productivity.

Microeconomic theory also supports the inclusion of labour savings in the justification of new capital equipment, because after all, substituting capital for labour should lead to productivity advance. On the contrary, the Swift, Even Flow Theory dismisses labour savings as an ICT justification based on the fact that it is not the capital expenditure in ICT that lead to gains but it is the ICT applications that can lead to swifter and more even flows of resources. In this vein, ICT that do not affect swifter and more even flows within the process but just automate isolated processes do not lead to enhanced productivity gains.

In the same vein, microeconomic theory argues for new, better capital investments and higher skilled labour. But the Theory of Swift, Even Flow advocates that it is not the policies themselves that can lead to enhanced productivity but it is their implementation if it either speeds up the flow of materials or if it reduces the variability of the process. Moreover, the Swift, Even Flow Theory does not lean one way or another with respect to scale economies, as increasing the scale of a process is not unambiguously good if it has no beneficial consequence on flows.

3.3.2 The Theory of Performance Frontiers

The theory of performance frontiers argues that productivity differences across time as well as companies can be due not only to fluctuations in efficiency differences (i.e. productivity in strict terms) but also to strategic decisions aiming at developing other organisational capabilities such as quality, flexibility (i.e. productivity in a broader sense). In these terms the Theory of Performance Frontiers and the Theory of Swift and Even Flow complement each other in explaining productivity differences. In fact, the theory of performance frontiers reflects and unifies an ongoing debate between the law of "trade-offs" and "cumulative capabilities" illustrating that the latter two concepts are not competing rivals, but are instead complementary.

The law of "trade-offs" implies that a manufacturing plant cannot simultaneously provide the highest levels among all competitors of product quality, flexibility and delivery at the lowest manufactured cost, while the law of "cumulative capabilities implies that improvements in certain manufacturing capabilities (e.g. quality, delivery, cost and flexibility) are basic and enable improvements to be made more easily in other manufacturing capabilities (e.g. flexibility) (Schmenner and Swink, 1998). Overall, the law of "trade-offs" is reflected in comparisons across plants at a given point in time, whereas the law of cumulative capabilities is reflected in improvement within individual plants over time.

For example, in the short run, a manufacturing plant is technologically constrained because technological choices put constraints on capabilities and so force trade-off among dimensions of performance that can be achieved (Skinner, 1996). However, over time, plants focusing their resources on achieving excellence in a few selected performance dimensions will, in those aspects of performance, necessarily outperform plants that pursue excellence in many dimensions of performance.

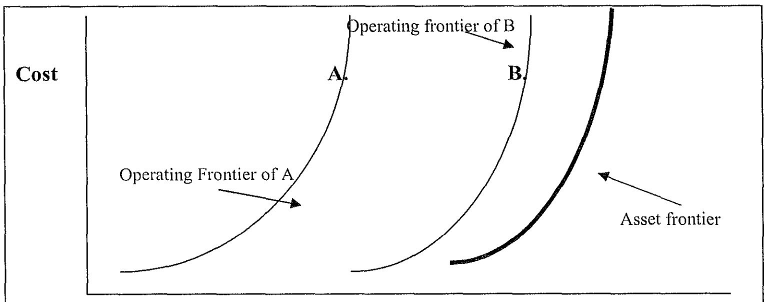
The performance frontier concept has been widely used under various names, e.g. "production function" and "trade off curve", but not well defined in the operations management literature (Schmenner and Swift, 1998). From an economic approach, a production frontier is defined as the maximum output that can be produced from any given set of inputs, given technical considerations (Samuelson, 1947). The performance frontier enlarges the scope of this definition by expanding the nature of output to include all dimensions of manufacturing performance (e.g. cost, product range, quality) consistent with notions of data envelopment analysis (Charnes, 1994). This also includes all choices affecting the design and operation of the manufacturing unit, including the sources and nature of inputs. Hence, a performance frontier defines the maximum performance (meaning efficiency, effectiveness etc, i.e. productivity in a broad sense) that can be achieved by a manufacturing unit given a set of operating choices (Schmenner and Swift, 1998).

Concerning the make up of the performance frontier, Schmenner and Swink (1998) claimed that it is formed by two types of choices namely, in plant design and investment and choices in plant operation. Hence, there are two frontiers, namely the operating frontier and the asset frontier, the former being altered by kinds of investments that would typically show up on the fixed asset proportion of the balance sheet, and the latter being altered by changes in the choices that can be made, given the set of assets that the plant management is "dealt".

Schmenner and Swink's (1998) conceptualisation of the performance frontier's boundaries are consistent with previous arguments and findings. Skinner (1996) identified technology as the source of limits on the dimensions of performance. Other writers (e.g. Hayes and Pisano, 1996; Clark, 1996) suggested that performance frontiers are formed and changed by manufacturing "systems" defined as the aggregate set of policies used to manage quality, production planning and control, and other procedures, such as just-in-time manufacturing, statistical process control, total quality management, continuous improvement and cross-functional integration (Clark, 1996). Manufacturing strategy concepts have also made clear distinctions between choices affecting physical assets and those affecting operating policies in manufacturing, using terms such as "structural" and "infrastructural" to classify these decisions.

An example is given in Figure 3.3.2.a which draws the performance frontiers of two hypothetical companies A and B. Both companies are located on their operating frontiers, which are located well within the asset frontier, which is shared because both companies utilise similar production equipment, e.g. technology and physical assets. However, they follow different management policies and so, each plant's performance is immediately bounded by its policies and procedures. Firm A is likely to operate under the laws of cumulative capabilities while firm B, due to diminishing returns on improvement, is more likely to be subject to the law of trade-offs. The operating frontier may be moved or changed e.g. by adopting an advanced manufacturing system, but ultimately performance is bounded by an asset frontier.

Figure 3.3.2.a Operating and asset frontiers



Operating and asset frontiers **Performance**

Source: Schemmenr and Swink, (1998)

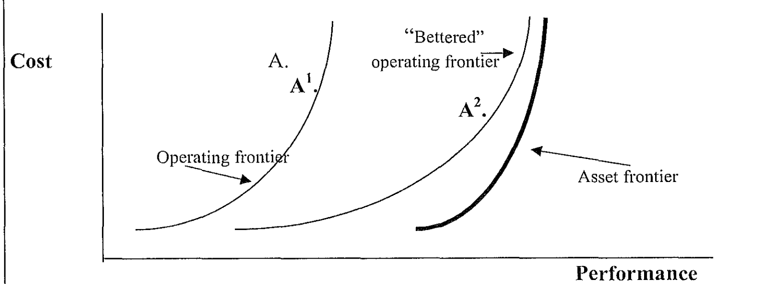
Because performance frontiers are affected and explained by two factors, it is clear that two types of performance improvement can be identified namely improvement and betterment (Schemmenr and Swink, (1998). Improvement is defined as increased plant performance in one or more dimensions without degradation in any other dimension, which is analogous to the Pareto optimality in microeconomic theory, and can be derived by increasing utilisation or efficiency in the sense of bringing performance up to a predetermined standard (e.g. standard hours). Under this strict definition, improvement has only to do with removing inefficiencies in transformation processes, which takes a company to its operating frontier (from A to $\mathbf{A^1}$ in Figure 3.3.2.b) and then improvement ceases. Improvement can result from changes in inputs, experience, motivation, planning and controls.

Betterment aims at maximising the effective use of available assets by choosing the management policies that better match with the capabilities of the available assets. In other words, betterment is about altering manufacturing operating policies in ways that move or change the shape of the operating frontier and bring it nearer to the asset frontier (from A to $\mathbf{A^2}$ in Figure 3.3.2.b). Betterment occurs in a number of ways such as Just In Time and Total Quality Management principles, which show that performance can be dramatically changed with little change in the amount or type of physical assets employed.

The asset frontier can also move as well, e.g. through radical technology upgrades or replacement, but because movement of the asset frontier normally requires large capital investments and radical changes to the physical company, this occurs less frequently than movements of operating frontiers (Schmenner and Swink, 1998).

In this vein, the Theory of Performance Frontier provides two reasons/explanations to that can be tested on why productivity differences may exist across hotels with different ICT configuration. Hotels may operate under different asset frontiers, i.e. may have invested in different and/or fewer ICT systems and applications. Hotels may differ in their management policies regarding how they use and apply ICT, i.e. use of ICT in order to implement just-in-time procurement, online reservations eliminating intermediaries/commissions and staff, Customer Relationship Management practices etc.

Figure 3.3.2.b Beneficial movements within the performance space



Three operating states for a manufacturing plant. Plant A is underutilised and inefficient. Rationalising resources and resolving inefficiencies leads to position A^1 at which the plant encounters its operating performance frontier. Operating policy changes improve the frontier moving the plant to A^2, where technological and asset constraints begin to significantly affect performance.

Source: Schmenner and Swink, (1998)

However, movement of performance frontiers is subject to two laws. According to the law of diminishing returns, as improvement (or betterment) moves a manufacturing plant nearer and nearer to its operating frontier (or its asset frontier) more and more resources must be expended in order to achieve each additional increment of benefit. For example, an increase in room occupancy from 75% to 95% might practically be achieved with a 27% increase in sales revenue, but that from 95% to 99% per cent might require much more marketing effort while the improvement in revenue only would be 4%. Moreover, the law of diminishing synergy implies that the strength of the synergistic effects predicted by the law of cumulative capabilities diminishes as a manufacturing plant approaches its asset frontier. For example, the beneficial impact on delivery reliability by improving quality from 8% defects to 5% defects is greater than the beneficial impact on delivery reliability by improving quality from 5% defects to 2% defects.

The laws of diminishing returns and diminishing synergy work together with the laws of "trade-offs" and "cumulative capabilities" to explain the nature of productivity differences within and among plants more completely than any of the laws do in isolation (Shmenner and Swink, 1998). So, by considering the position of a plant's operating frontier and its relative position to the asset frontier, predictions can be made regarding the applicability of the laws of trade-offs and cumulative capabilities. Specifically, the law of cumulative capabilities is more applicable to businesses that are not tightly bound by an asset frontier, while the law of trade-off is more applicable to businesses that are close to their asset frontier.

Because of that, two suggestions were provided (Schmenner and Swink, 1998):

- Businesses that operate near their asset performance frontier will reap greater benefits from structural, technological changes than businesses that operate far away from their operating frontier.

- Businesses that are not near their frontiers are not likely to enjoy as high returns on these investments because the frontier is largely irrelevant to them. Instead, they would benefit more from a cumulative improvement approach aimed at improving infrastructure and operating efficiencies (such as quality-related improvements).

There is an old adage that operations management is all about "doing the right things, and doing them right". In the same vein, the Theory of Performance Frontiers suggests making the right process choice (getting the asset frontier right to optimise smooth and even flow) and then operating the layout as efficiently and effectively as possible (managing the operations frontier to achieve smooth and even flow) in order to ensure that the operation is as close as possible to its performance frontier. Moreover, the Theory of Performance Frontiers illustrates the impact that assets and resource utilisation can have on strategy formulation and development. This is because by locating themselves on their performance frontiers as well as on those of their competitors, businesses can identify the strategic and operational decisions that should be taken. In other words, the performance frontiers also illustrate the relationship that exists between performance measurement/benchmarking, strategy and operations management (as the frameworks of Jones and Lockwood, 1995; Dyson, 2000) and the reasons of performance differences (as Jones and Lockwood's, 1995, framework).

Moreover, Jones (2000) argued that there is little or no research comparing the relative performance of operations performing with different asset frontiers and so the next big step in research is to truly get to grips with measuring firms' asset frontiers to better understand the real dynamics of the industry. McKinsey Global institute (1998) also provided evidence of such need by revealing many instances of operations with a capital infrastructure that is highly inefficient.

3.4 Conclusions

In the context of quantitative thinking, based on productivity ratio analysis five strategies for increasing productivity emerge namely, paring down, cost reduction, managing growth, working smarter and innovation. Moreover, there is evidence to suggest that these are dependent upon a number of variables, such as technology, processes, type of operation and maturity of the firm. These are simplified arguments about the contractive and expansive strategies to productivity improvement. Consistent with the notion a "family or hierarchy" of productivity measures (discussed in chapter two), it was also identified that these approaches to productivity improvement could also be viewed as applications at different levels within the firm. Finally, recent operations management theories, that of performance frontiers and Swift and Even Flow, explain in detail all these and provide a mean by which these alternative perspectives could be pulled together.

3.5 Summary

It was made evident that models and explanations of productivity improvements depend on the approach of the productivity is conceptualised. Overall, conflicting and/or different arguments from six perspectives were presented namely positive thinking, systems theory, scientific management, behavioural science, operations and economics. However, for the purposes of this study, research needs to be based on one paradigm. To that end, two theories from the operations management literature, i.e. the Theory of Performance Frontiers and the Theory of Swift and Even Flow, were analysed and used as the theoretical underpinnings of this study for the following reasons:

- It unifies previous theories and values and summarises them into two theories explaining productivity differences; in this vein, it is consistent with arguments regarding productivity improvement provided from different perspectives;
- Its theoretical underpinning can easily explain productivity improvements fostered by ICT and it helps in formulating hypotheses to be tested as follows:
    - Hotels with different asset frontier (i.e. the ICT assets/resources) differ in their productivity levels; and
    - Hotels with different operating frontier (i.e. the applications/usage of ICT) differ in their productivity levels;
- Its values are based on the concept of production frontiers for which there is a well-established statistical methodology for testing its hypotheses.

In this vein, it becomes evident that two issues need to be investigated: 1) define and measure the ICT assets and resources and demonstrate how they impact on productivity; 2) identify, define and measure ICT applications and illustrate how they impact on productivity. These two objectives are met in the following chapter.

CHAPTER FOUR

DEA

The precious two chapters identified two crucial issues. First, productivity measurement faces problems that relate to three stages of productivity measurement process. Second, a unified theoretical paradigm namely the Theory of Performance Frontiers explains productivity differences by using a well-established statistical methodology. These two issues can be solved and addressed by the DEA methodology. Thus, the aim of this chapter is to:

a) present and analyse DEA and illustrate how it relates to the Performance Frontiers or to the production function theories;
b) identify and illustrate its advantages and disadvantages for productivity measurement relative to other productivity measurement techniques;
c) argue how DEA can be used in order to overcome problems relating to the three stages of the productivity measurement process;
d) demonstrate how DEA is applied and identify the crucial issues that need to be answered when using DEA;
e) demonstrate the usefulness of DEA by identifying its use in previous studies.

4.1 Introduction, origins and concept of DEA

DEA is a multivariate, non-parametric technique that benchmarks units by comparing their ratios of multiple inputs to produce multiple outputs at the same time and by using the concept of the performance frontier (Avkiran, 1999a). Under the DEA technique, there is no particular structure superimposed on the data in identifying the efficient units, and so it becomes a valuable tool in benchmarking (Al-Faraj et al, 1993). The origin of the non-parametric programming measurement, in respect of relative efficiency measurement, lies in the research work undertaken by Charnes, Cooper and Rhodes (CCR). If Farrell's 1957 paper is taken as a seminal work, the CCR research reported in 1978 is undoubtedly the basis for all subsequent developments in the DEA non-parametric approach to evaluating technical efficiency.

In their original paper (1978), CCR introduced the generic term "Decision Making Units" (DMUs) to describe the collection of firms, departments, divisions or administrative units which have common inputs and outputs and which are being assessed for efficiency. The focus for CCR's research was on decision making by "not-for-profit" entities. This meant they could concentrate on multifactorial problems (particularly with reference to outputs) and they could discount economic weighting factors such as market prices. However, the CCR approach has been proved applicable to both the private and public sector. Since its introduction, it has been applied successfully to assess performance in different industries, especially when accounting and financial ratios are of little or no value (Charnes et al, 1994; Norman and Stoker, 1991). In fact, DEA can actually be used to benchmark the performance of any system, because DEA modelling allows the analyst to select inputs and outputs in accordance with the managerial focus and the desired analysis.

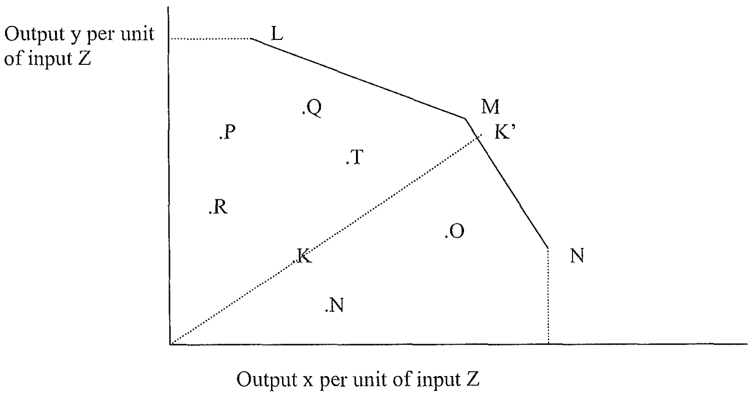
In general terms, DEA technique can be described as follows, while its mathematical formulas are given in Appendix A:

The efficiency measure of a Decision Making Unit (DMU) is defined by its position relative to the frontier of best performance established mathematically by the ratio of weighted sum of outputs to weighted sum of inputs

Simply, the process of DEA works as follows. DEA compares the inputs and outputs of similar DMUs, whereby the similar units are identified based on their input and output measures. Inputs and outputs of all the DMUs are categorised into efficient and inefficient combinations, so that the efficient input-output combinations yield an implicit production frontier, against which each DMU can be evaluated. If the DMU's output-input combination lies on the DEA frontier, it is considered efficient (100% efficiency score), and conversely if it lies off the frontier it is considered inefficient (<100% efficiency score). In essence, therefore, DEA compares the efficiencies of a number of DMUs, based upon the inputs they require and the outputs they achieve and efficient DMUs are determined without any preconceived structure imposed on the data (Banker, 1984, Al-Faraj et al 1993, Avkiran, 1999). Thus, the production frontier is generated piece-by-piece in a linear fashion from the available input and output data, using linear programming techniques and so, the inefficiency in a particular DMU is identified by comparing it to similar DMUs that are regarded as efficient. This contrasts with parametric approaches in which a particular functional form is assumed for the production function, (e.g. Cobb-Douglas) which is then used to generate a stochastic production frontier.

Figure 4.1.a shows a simple model of DEA highlighting its principle. The solid line going through efficient DMUs L, M and N depicts the efficient frontier that represents achieved efficiency. Clearly, the efficient frontier envelops all other data points, thus giving rise to the name Data Envelopment Analysis (DEA). For example, DMU K is classified as inefficient in this sample of ten units and it needs to travel to K' on the frontier before it can also be deemed efficient. DMU K would be directly compared to units M and N on the efficient frontier (i.e. its reference set or peer group) in calculating its efficiency score. In this case, DMU M would make a greater contribution to DMU K's score.

Figure 4.1.a A two-output, one-input DEA model showing the efficient frontier



Source: Avkiran (1999)

CCR's work was not universally accepted by economists who continue to develop parametric techniques. Grosskopf (1986, in Norman and Stoker, 1991, p. 16) describes how *"many economists believed that the non-parametric approach is obsolete, largely because of the restrictions placed on the technology in the early studies employing that approach"*.

Grosskopf (1986) proceeded to point out that the non-parametric approach is much more flexible than had been suggested and that it has been underestimated by economists. Hildenbrand (1983) also argued that DEA is a very clear analysis that overcomes two major problems of parametric techniques, i.e. unobtainable economic data and the ad hoc specification of the production frontier that does not reflect the actual structure.

A number of methodological enhancements were introduced since the appearance of the basic DEA model in 1978, e.g. the presence of variable returns to scale, the presence of categorical variables, the use of DEA to set targets, and the ability to capture judgements within a DEA content. Charnes et al (1994) give an extensive discussion of the majority of the basic DEA formulations and their enhancements.

4.2 DEA methodology

The DEA methodology uses the concept of "relative efficiency". The concept of economic efficiency flows directly from the microeconoomic theory of the firm. Perhaps the most basic concept is that of the production frontier, which indicates the minimum inputs required to produce any given level of output for a firm operating with full efficiency (Cummins and Weiss, 1998, p. 4). In some respects DEA is based on a concept of efficiency, which is similar to a classical production function approach, i.e. a comparison of output with input. However, in DEA the production function does not have to be pre-determined but it is generated from the data set of the observed operating units. Unlike the production function, the DEA score is thus independent of the units in which output or input are measured, and this allows for great flexibility in specifying the outputs and inputs to be studied.

In a subsequent paper, Charnes et al (1985) give their formal definition of efficiency by arguing that 100% efficiency is attained for (a unit) only when:

a) none of its outputs can be increased without either i) increasing one or more of its inputs, or ii) decreasing some of its other outputs;
b) none of its inputs can be decreased without either i) decreasing some of its outputs or ii) increasing some of its other inputs

This definition accords with the economist's concept of Pareto (or Pareto-Koopmans) optimality. If we have no way of establishing a "true" or theoretical model of efficiency, that is some absolute standard, we have to adapt our definition so that it refers to levels of efficiency relative to known levels attained elsewhere in similar circumstances. Again, Charnes et al (1985, p.96) supply the definition:

"100% relative efficiency is attained by any (unit) only when comparisons with other relevant (units) do not provide evidence of efficiency in the use of any input or output"

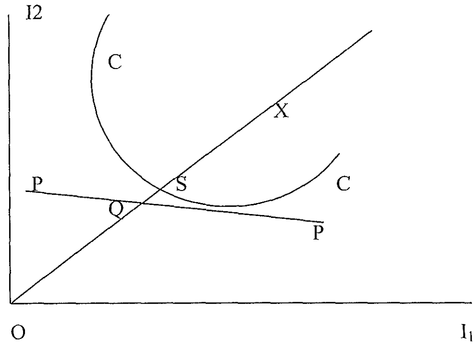
Farrell (1957), a pioneer in this field, demonstrated that "overall efficiency" can be decomposed into "allocative efficiency" and "technical efficiency". Technical inefficiency represents deviations from efficiency that result from poor input utilisation (pure technical inefficiency) and from firms failing to operate at the optimal size (scale inefficiency). Allocative inefficiencies represent deviations from the efficient frontier that result from sub-optimal allocation of inputs. Technical efficiency (T), measured as the radial distance that X is from the isoquant, and allocative efficiency (A), measured as the radial distance from the cost minimisation plane, are given by (Figure 4.2.a):

$T = OS / OX$ and $A = OQ / OS$

While, overall efficiency can be computed from A and T as follows:

$E = OQ/ OX = OQ/ OS \times OS/ OX = A \times T$

Figure 4.2.a Calculation of technical and allocative efficiency



Moreover, the nature of technical inefficiencies can be due to the ineffective implementation of the DMU in converting inputs to outputs (pure technical inefficiency) and due to the divergence of the DMU from the most productive scale size (scale inefficiency). Decomposing technical efficiency (TE) into pure technical efficiency (PTE) and scale efficiency (SE) allows an insight into the source of inefficiencies. It also helps determine whether DMUs have been operating at optimal returns to scale (ORS), increasing returns to scale (IRS) or decreasing returns to scale (DRS). The Constant Returns to Scale (CRS) efficiency score represents technical efficiency which measures inefficiencies due to the input-output configuration and as well as the size of operations. On the other hand, the Variable Returns to Scale (VRS) efficiency score represents pure technical efficiency, that is, a measure of efficiency without scale efficiency. It is thus possible to decompose TE into PTE. Scale efficiency can be calculated by dividing PTE into TE. The graphical derivation of this relationship can be found in Coelli et al (1998).

Stoker and Norman (1991) provided the following definitions:

Increasing returns to scale exist where an increase in input(s) (keeping the mix constant where there is more than one input) results in a greater than proportionate increase in output.
Decreasing returns to scale exists where the result is a lesser than proportionate increase in output.
Constant returns to scale exists where the result is a proportionate increase in output.

On the ground of the economists' arguments that efficiency can be due to two reasons, Tatje and Lovell (1997) claimed that economic and business literature discuss the same problem, i.e. "how business profit change can be allocated to its constituent sources", from different aspects and they went on applying the DEA model for decomposing profit differences between businesses. Analytically, they claimed that in business theory, profit change is decomposed in three sources: the price effect, including changes in resources prices paid and product prices received; the productivity effect, typically attributed solely to an improvement in technology; and the activity effect, capturing the effect of changes in the size, and less frequently, the scope of the business (Tatje and Lovell, 1997, p.2). In this framework, changes in profit are attributed to changes in: a) the product and resource prices (allocative efficiency, similar to the price effect in the business literature); b) the structure of production technology (scale efficiency similar to the activity effect in the business literature) and c) the structure of production technology and changes in operating efficiency between two periods (pure technical efficiencies/operating efficiency, similar to the productivity effect in the business literature).

For instance, Anderson et al's study (1998) provides an excellent example in measuring inefficiency and decomposing it in its elements, i.e. scale and allocative inefficiencies. They also went on further investigating whether franchise residential real estate brokers significantly differ in their efficiency measures from non-franchise operators.

In applying DEA to hotel productivity, Anderson et al (1999a) identified two fundamental reasons for firms operating sub-optimally. First, the failure to allocate resources in the most efficient manner (allocative inefficiency), since resources have different prices and second, a firm's ability to utilise its resources given their allocation (technical inefficiency).

In the same vein, Schmenner and Swift (1998) applied economists' work on production frontiers and claimed that performance frontiers are constructed by two similar frontiers, i.e. the availability of different resources and assets (asset frontier) and the use of different management principles (operating frontier). Hence, they (1998) also provided two reasons for productivity differences namely, investment in equipment and infrastructure (i.e. betterment, shift of asset frontier) and use of management practices (i.e. improvement, shift of operating frontier). The selection of the approach to productivity improvement was argued to depend on the location of the firm relative to its own frontiers and that of its competitors (and thus the need for external benchmarking).

It is evident that DEA is closely related to and reflects Schmenner and Swift's (1998) theory of performance frontiers. It can thus be argued to be appropriate for benchmarking hotels performance, identifying performance frontiers and then investigating whether performance differences relate to ICT configuration metrics, provided though that appropriate input, output factors are identified and used.

In summary, the basic concept of DEA is summarised as follows (Trait, 19/11/99):

- Comparative technique;
- Calculates the efficiency with which "production units" consume resources to create added value;
- Resources are defined as a set of "input" variables that are used to generate "output" variables;
- Uses ratio metrics as basic concept of efficiency;
- Data driven technique;
- Quantitative approach;
- Based around a sequence of underlying optimisations;
- Uses mathematical programming to perform optimisations.

4.3 Advantages of DEA

The advantages of DEA for productivity measurement are better measurement of the relationship between inputs/outputs as well as the other two considerations regarding productivity measurement, i.e. the selection of inputs/outputs and their units of measurement.

The major advantage of DEA is that it can simultaneously consider multiple inputs and outputs and so, it can overcome the limitation of ratio analysis. Moreover, by handling several different inputs and outputs at the same time, in principle, it should be capable of overcoming the ceteris paribus problem (Johns, 1997, p.122).

However, based on empirical findings and the experience of DEA practitioners, the following relationship should exist between the number of service units (K) used in the analysis, the number of input (N) and output (M) types being considered (Avkiran, 1999):

$K \geq 2 (N + M)$

This is because if there are M outputs and N inputs we would expect the order of tm possibilities that DMUs could be efficient and so the identification of at least tm efficient units, which in turn means that the number of units in the set should be substantially greater than tm, in order for there to be suitable discrimination between units (Dyson, Thanassoulis and Boussofiane, 1990). Anderson (1996) also noted that the sensitivity of the method is related to the number of inputs and outputs on which the DEA scores are based. He noted that scores based upon a large number of inputs and outputs tend to discriminate less between hospitality units than those which restrict themselves to two or three measures. However, restriction of the variables in this way effectively reduces the frame of reference, i.e. the "family of measures", and so the alternative solution is to increase the size of the sample.

DEA can use any type of measurement quantities to make its comparisons, i.e. is not limited to monetary units, and it also works with variables of different units at the same time (Avkiran, 1999, p. 207).

DEA modelling allows the analyst to select inputs and outputs in accordance with a managerial focus (Avkiran, 1999, p.207). Hence, DEA can be used in order to assess the performance of any system relative to its objectives, provided that its inputs/outputs can be easily identified. Also DEA opens the door to what-if analysis. However, this is not an open invitation for the analyst to produce DEA models that would not stand up to scrutiny of their rationale. While it is possible to select variables based on various managerial focuses, a good starting point is to identify the key business drivers critical to success of the examined DMUs that usually previous studies have identified.

Another advantage of DEA is that it can allow the optimisation program to determine the weights for each variable, which can be used to identify where along the efficient frontier a particular DMU would be located if that DMU were efficient (Weber, 1996, p.30). The usefulness of weights is mainly understood when the management is concerned that a variable might be underrepresented or over-represented in calculation of efficiency scores when real life considerations indicate otherwise. An important caveat about using weight restrictions is that too many restricted variables severely handicap the optimisation process in DEA. The reason for that is explained by Dyson, Thanassoulis and Boussofiane, (1990, p.3):

"The concern with the DEA is that by judicious choice of weights a high proportion of units in the set will turn out to be efficient and DEA will thus have little discriminatory power. The first thing to note is that a unit which has the highest ratio of one of the outputs to one of the inputs will be efficient, or have an efficiency ratio very close to one by putting as much weight as possible on that ratio and the minimum weight on the other inputs and outputs. In a typical analysis each such ratio may be associated with a different unit and the number of such ratios will be the product of the number of inputs and the number of outputs. However, increase of the number of inputs/outputs without increase in the sample size negatively affects the power of DEA. A unit can appear efficient simply because of its pattern of inputs and outputs and not because of any inherent efficiency. An approach to resolving this issue is to constrain the weights by determining a minimum weight for any input and output, which would ensure that each input/output played some part in the determination of the efficiency measure. Similarly a maximum limit could be placed on the weights to avoid any input or output being over-presented."

DEA also allows the inclusion of factors in the model that are exogenous and out of management control as well as of variables that may characterise and represent particular management practices of the DMUs, e.g. size of the unit, hotel star category, affiliation to a marketing consortia, demand levels etc. Overall, it is evident that with DEA performance is assessed against:

- Desired objectives
- The means used to attain objectives
- External barriers to success.

Several techniques are found in the literature to investigate and measure the effect of particular variables in performance. Charnes et al (1981) presented an analytical process of using DEA in order to decompose the effects of different variables on performance. Cummins and Weiss (1998) also argued how frontier analysis can also be used in order to inform management about the effects of policies, procedures, strategies and technologies adopted by the firm.

Chatzoglou and Soteriou (1999, p.512) also used DEA in order to benchmark the effects of different variables on the software development process. They did this by dividing their sample into three homogeneous groups based on the variables they wanted to examine and described their analytical process as follows. First, DEA is applied to each group separately in order to examine efficiency differences within a group. Managerial inefficiencies within each group can be identified, and ways of improvement can be suggested based on the model's recommendations. Second, managerial DMUs inefficiencies observed within the groups are removed. This can be done by projecting inefficient DMUs onto their efficiency frontier. A set of virtual and efficient projects is then constructed for each group. Third, DEA is applied to the pooled data set considering all efficient and virtual projects from both groups under consideration. Between group differences can now be identified by examining if efficiency distribution differences exist across groups. Information on how DMUs can benefit from management practices observed in projects operating in different groups can be obtained.

DEA was used in a similar approach by Frei and Harker (1996) in order to address the question of how much efficiency in a business process is due to the wrong process design and how much is due to the right design but poor execution. Their methodology demonstrated the trade off and offered specific recommendations for either improving an existing process or radically changing to a different design. However, the major limitation of their study was that they focused on the efficiency of only one process whereas the service delivery system rarely consists of a single process. The steps of their methodology are analysed as following (Frei and Harker, 1996, p. 10):

1. use DEA in order to determine the efficiency score, reference set, and frontier projection for the entire data set;
2. separate the data into process-design groups using obvious break points in the managerially actionable design characteristics or, more formally, through cluster analysis;
3. determine if the set of overall efficiency calculated in step 1 is statistically different for each of the process design groups defined in step 2;
4. as described in step 1, determine the efficiency score, reference set and frontier projection separately for each process-design group;
5. isolate the portion of overall inefficiency that is due to poor performance and the proportion that is due to the wrong process design. The overall and design-group efficiency scores have been determined in steps 1 and 3, respectively. If the DMU is inefficient in both cases, then the portion of the overall inefficiency that is due to poor execution is Efficiency within the design group / Efficiency within the overall sample, while the portion of inefficiency due to the wrong process design is 1 – Efficiency within the design group / Efficiency within the overall sample. If the DMU is inefficient overall but efficient in its design group, then the overall inefficiency is attributable to the wrong design;
6. determine the specific managerial recommendations for improvement, both within a design group, as well as for the entire set of DMUs. This step is obviously context dependent.

The ultimate objective of DEA is to determine which DMUs are operating on their efficiency frontier (i.e. achieve an efficiency of 100%) and which are not. However, DEA can answer the question not only "how well are we doing" but also the question "how much could we improve". In other words, it identifies areas of performance that are critical to the success of the DMU. So, apart from comparing a group of service units to identify relatively inefficient units, corporate management can also use DEA to measure the magnitude of the inefficiencies and by comparing the inefficient with the efficient ones, discover ways to reduce those inefficiencies or identify potential improvements.

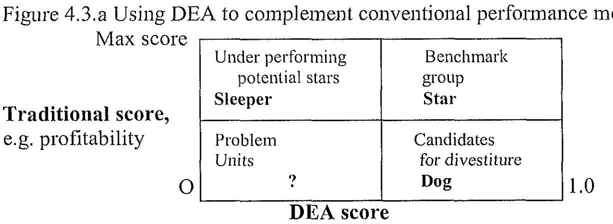
Another usefulness of DEA is that it identifies the DMUs to benchmark (Avkiran, 1999, p.206). DEA identifies a unit as either efficient or inefficient compared to other units in its reference set, where the reference set comprises efficient units most similar to that unit in their configuration of inputs and outputs. Therefore, in identifying inefficient DMUs, only a part of the entire efficiency frontier is relevant, called a "facet", consisting of what is referred to as the "efficient reference set" of DMUs. Knowing which efficient DMUs are most comparable to the inefficient DMU enables the analyst to develop an understanding of the nature of inefficiencies and re-allocate scarce resources to improve productivity (e.g. a DMU can increase its outputs using the same inputs, or produce the same outputs using fewer inputs). This feature of DEA is clearly a useful decision making tool in benchmarking and DEA has been extensively used for performance benchmarking (Al-Shammari & Salimi, 1998; Chatzoglou and Soteriou, 1999).

Overall, Banker and Thrall (1992) highlighted the following advantages of DEA for performance benchmarking:

- DEA is independent of the units in which inputs and outputs are measured, which gives great flexibility in specifying the outputs and inputs to be studied.
- DEA compares *simultaneously* multiple inputs and outputs of comparable operating units and generates *one* overall performance score by using a "benchmark" score of unity (i.e. the optimum performance within the comparison set of units).
- DEA can answer the question not only *"how well we are doing"* but also the question *"how much could we improve"*. DEA can separate the best practices (units with unity efficiency score) from inefficient units as well as it can both identify and measure the magnitude of the inefficiencies, indicating ways for potential improvements.

Moreover, DEA can be used in combination with other more conventional performance measures for deriving more information and taking relevant decisions. For example, Oral et al (1996) argued that it is advisable to complement assessment of operational efficiency through DEA with ratio analysis that measures financial performance. This is because a firm can be profitable but not efficient in using and managing its resources. Johns (1997) argued that a sound managerial practice would be to compare profitability measures with DEA results and to investigate significant disagreements investigated. The management should also be particularly keen to know if DEA results are consistent with those from other performance analysis. Such a comparison can be carried out by looking at some key indicators and making a judgement as to how well a unit is doing "on the whole", but a more effective approach is to compare inefficient units with their reference sets. Thus, the use of a mixture of techniques is useful for extending the range of management information. Dyson, Thanassoulis and Boussofiane (1990) gave an example of how the results of other techniques can be plotted against the DEA results by using a DEA/traditional scores matrix similar to the BCG matrix, (Figure 4.3.a).

Figure 4.3.a Using DEA to complement conventional performance metrics



Source: Dyson, Thanassoulis and Boussofiane (1990)

Stars should provide examples of good operating practice and are probably also in favourable environment. The sleepers are profitable but this is more to do with favourable environmental conditions than good management. They are candidates for an efficiency drive leading to even greater profits. The question marks have potential for a greater efficiency and possibly greater profits. Attempts should be made to increase their efficiency and this may lead to greater profitability. The dogs are efficiently operated units but low on profitability due to an unfavourable environment.

Johns (1997) claimed that DEA could be an ideal management tool in the affiliated sector of the hospitality industry whereby a head office of a hotel chain can monitor the performance of individual units. He (1997) also argued that DEA can also be used as:

- a basis for discussing key performance factors and hence the motivation and appraisal of local management, as well as for budgetary control;
- a means of benchmarking progress over time and as such it might form the basis of a company-wide productivity management system, of the type advocated by Heap (1992). Benchmarking is recognised as a key factor in the maintenance of management systems designed for productivity improvement. Frontier analysis can be used not only to track the evolution of a firm's productivity and efficiency over time or across firms but also to compare the performance of departments, divisions, or branches within a firm (Cummins and Weiss, 1998, p. 3);
- a means of feedback (and hence motivation) for productivity improvement teams, analogous to quality circles;
- a basis of appraisal and recognition schemes at all employee levels (Anderson, 1999b, p.267);
- a basis for developing a productivity "culture", as the publication and dissemination of productivity metrics keeps the productivity issue "live" within an organisation, so that eventually productivity is simply seen as "the way we do things around here". Heap (1992) also emphasised this aspect, which is also a well-known characteristic of quality improvement systems;
- as a tool for identifying specific local problems.

In summary, DEA attributes are given as follows:

- It provides a comprehensive efficiency evaluation and derives a single aggregate score, taking into account all inputs and outputs;
- It objectively assesses the "importance" of the various performance attributes;
- It is capable of identifying any perceived slacks of input used or output produced and it provides possibilities for improvement;
- It evaluates each entity in the best possible light – all alternative priorities will reduce performance;
- It calculates efficiency based on observed best practice – not against an "average" or "ideal" model;
- It automatically highlights the peers against which an inefficient entity's performance has been judged;
- It focuses on dominant (observed), rather than average strategies.

Mahmood et al (1996) also provided a comprehensive summary of the advantages of DEA over other methodologies:

- no functional relationship between inputs and outputs needs to be prespecified;
- multiple outputs and inputs can be considered simultaneously;
- inefficient DMUs can be identified;
- the sources and the amounts of inefficiency for each inefficient project can be identified, and;
- specific inefficiencies that may not be detectable through other techniques such as regression or ratio analysis can be detected (Epstein and Henderson, 1989; Sengupta and Sfeir, 1988).

Actually, two main techniques have been used to improve on single-indicator performance measures: econometric approaches [i.e. deterministic cost frontier (COLS), stochastic cost frontier and canonical regression] that estimate a production or cost function by fitting a regression plane to the data; and DEA which as previously mentioned uses linear programming techniques to construct a frontier that envelops all observations. Although there are no theoretical grounds for generally preferring DEA to regression analysis or vice versa (Giuffrida and Gravelle, 2001), the two techniques have certain properties that can justify their selection for achieving the relevant research purposes. DEA can easily model multiple input and multiple output production processes, while regression analysis can only address a single input to multiple outputs or multiple inputs to single outputs, unless canonical regression is used. DEA does not require specification of the functional form of the production (or cost) function, while econometric methods do. Criticisms of the methodological grounds of previous studies investigating the ICT productivity paradox using econometric methods have already been discussed in section 6.3.1.5. In contrast to econometric methods, DEA identifies and provides information about peer organisations and it is not as vulnerable to small numbers of observations as regression analyses. These advantages of DEA over econometric techniques are compatible with the aims and nature of this research. Previous studies comparing DEA with econometric methods have also provided some guidelines regarding when to use one method over another.

- Smith (1997) provided evidence that DEA produces reasonably accurate estimates with small samples (as is the case here due to the limitations of data collection);
- Banker et al (1993) also showed that DEA gives more precise estimates over deterministic cost frontier when the sample size is less than 50 as well as when inefficiency has an exponential distribution (which was the case in this study as no hotel had an inefficiency score of less that 30%);
- In comparing stochastic frontier regression, Gong and Sickles (1989 and 1992) found that the former outperform DEA if the assumed functional form is close to the underlying technology, but as the misspecification of the functional form becomes serious, DEA estimates become more accurate than the econometric based estimates; this confirms concerns regarding the methodological robustness of studies on the ICT productivity paradox using econometric techniques (section 6.3.1.5), and indeed the functional form for this study is not known;
- In comparing stochastic frontier methods with DEA where the assumed specification of the production function was good, Read and Thanassoulis (1995) provided evidence that the former methods are more vulnerable to extreme values. Their estimates were worse than DEA when one of the input or output variable was very large or very small;

- Ruggiero (1998) has shown that in the case that the true production function is a Cobb-Douglas canonical regression estimates were more highly correlated with the true efficiency irrespective of whether irrelevant input or output variables were included in the models estimated. The performance of the two methods for other technologies was not considered;
- In comparing the DEA with econometric techniques by calculating the correlations of their efficiency scores taken across years, Giuffrida and Gravelle (2001) found that regression methods performed better than DEA methods. Performance of methods across years is not crucial for this study since productivity comparisons are made across hotels and not across time. However, they have also shown that rankings of DMUs by their efficiency scores are very sensitive to the model used (i.e. the type and number of inputs/outputs included), much more than to the choice of the methodology or the year.
- Taking account of these two previous arguments and in order to address any potential methodological problems, the input and output variables used in this study were very carefully selected. Their inclusion in the DEA models was justified by applying a stepwise DEA approach. According to this technique only those inputs/outputs and environmental factors that significantly affect the efficiency scores are included in the DEA models. When no other significant correlation between the efficiency score and any input, output or environmental factor is found, then the DEA model is argued to be a robust metric.

4.4 Disadvantages of DEA

On the other hand, several authors have highlighted DEA limitations (e.g. Johns, 1997; Anderson et al, 1999a and 1999b; Miller and Noulas, 1996; Mester, 1996). These are analysed as follows.

DEA is more effective in large groups than small ones, and it becomes more satisfactory as the number of DMUs increases relative to the combined number of inputs and outputs; however, DEA can be used with small sample sizes (Evanoff and Israilevich, 1991) and many such examples are found in the literature (e.g. Sherman and Gold, 1985; Parkan, 1987; Oral and Yolalan, 1990; Haag and Haska, 1995).

An important assumption of DEA is that all DMUs face the same unspecified technology and operational characteristics, which defines the set of their production possibilities (Johns, 1997). Thus, it is important to use a homogeneous group of DMUs in DEA if confounding effects are to be minimised and results are to be comparable (Avkiran, 1999); e.g. full service hotels cannot be joined with B&Bs because these businesses are subject to different operational and production variables. In addition, this may limit the type of hotel group within which it may be used.

Further, Anderson et al (1999a and 1999b) claimed that DEA has been criticised in the literature as having the following serious potential statistical shortcomings. First, DEA is sensitive to the input/output specification of the model and so model specifications can dramatically influence the efficiency scores. Second, DEA can only measure relative efficiency levels as opposed to optimal efficiency. Hence, if one firm in the sample is much more or much less efficient than the average firm in the sample, the DEA will produce large inefficiency measures. In addition, efficient firms are only efficient in relation to others in the sample and they do not necessarily produce the maximum output feasible for a given level of input (Miller and Noulas, 1996; Weber, 1996, p. 29). However, it would be more informative to determine deviations from a true "best practise" frontier as opposed to the best sample firm frontier. Furthermore, DEA is a non-parametric technique rather than a regression-based approach and so it assumes that data are free of measurement error (see also Mester, 1996). Therefore, any deviation from the frontier is deemed inefficiency but this tends to over-estimate X-inefficiencies in that deviations might simply be a function of random error. While the need for reliable data is the same for all statistical analysis, DEA is particularly sensitive to unreliable data because the units deemed efficient determine the efficient frontier and thus, the efficiency scores of those units under this frontier as well. So, an unintended reclassification of efficient units could lead to recalculation of efficiency scores of the inefficient units.

However, ways to overcome such limitations have also been provided. So, when extreme performing DMUs are identified, the very high or very low efficient DMUs can be taken out of the sample and then be recalculated efficiencies in order to eliminate the possibility of them obscuring the efficiency results. As concerns the separation of deviations from the efficient frontier into the random error and X-inefficiency components, several other techniques have been developed (e.g. stochastic frontier approach, thick frontier approach and the distribution free technique, Anderson et al, (1999a, p. 48-49).

However, when Anderson et al (1999b) re-estimated the efficiency levels using the same data as Bell and Morey (1995) used in their DEA model, it was illustrated that although efficiency scores derived from stochastic frontier methods were higher than DEA scores (which was expected as they allow for statistical random errors), there was a consistency in the results derived by both techniques (i.e. firms were found to operate efficiently). In turn, this demonstrated that both techniques can result in robust results. Anderson et al (1999a) also concluded the same as the stochastic frontier approach they used in order to measure efficiency in the hotel sector illustrated high efficiency in the industry as did the DEA scores in Morey and Dittman's (1995) study.

However, the purpose of this study is not to calculate the exact differences and magnitudes of efficiency scores relative to the best observed practises but rather to identify whether there are differences in efficiency between properties, identify factors determining such differences and then investigate whether ICT metrics can explain them. However, whatever the case, the powerfulness of DEA is demonstrated by its strong presence in the literature.

4.5 Application of DEA to productivity

Productivity measurement requires the determination of three decisions; the selection of inputs and outputs as well as their measurement units and a way to relate them. DEA is only a statistical technique relating multiple inputs with outputs at the same time, and it so resolves one issue regarding productivity measurement. Thus, in applying DEA for productivity measurement the other two issues also need to be determined and all the previously mentioned issues regarding them also apply for DEA. However, these are not going to be repeated here, but it is highlighted that the selection of inputs and outputs and of their measurement units would depend on how the productivity has been conceptualised.

So for example, DEA can be used in order to give a fruitful insight into the different dimensions of the productivity concept. For example, DEA assesses labour productivity if a number of labour-related input variables are selected. If the selected input variables describe all or most of the resources being used in the production of output, then DEA measures total productivity. If variables are measured in units commensurate with the ultimate goal of activity, then DEA measures efficiency. In this vein, depending on the inputs and outputs incorporated into its DEA models, this study calculated both operational and market efficiency/productivity, depending on whether the DEA productivity ratio included the metric of business variability or not. As concerns the particular issues arising when using DEA for productivity measurement, the following analysis is provided.

4.5.1 Selection of input and output factors

Although the major advantage of DEA is that inputs and outputs can be determined in light of the desired analysis, this should not be wrongly used constructing haphazard models. A useful analysis is to identify the business drivers critical to the success of the DMUs, which basically involves the identification of performance variables (outputs) that represent the strategies and objectives of DMUs (Avkiran, 1999). Once outputs are determined inputs achieving the former can easily then be identified.

However, because it is often the case that numerous input and output factors can be taken into consideration, Norman and Stoker (1991) suggested that the first step of input/output selection is to be clear about which factors: a) refer to the objectives of the business; b) refer to activities that are undertaken to support the production of those outputs; and c) refer to factors influencing productivity. To that end, they (1991) also suggested a categorisation of outputs and inputs as well as provided the following guidelines in terms of output and inputs selection:

Final output- a direct measure of the degree of achievement of an objective. For example, if an objective is to sell rooms, the value of rooms sold is a final output.

Intermediate output- an indirect measure of the degree of achievement of an objective – used as a substitute when a final output is not available, either through inability to measure or lack of data. For example, if an objective is to provide a high quality customer service we have no direct measure of that service, but number of complaints may be used as an intermediate output.

Means to achieving an output (influencing) – not a measure of the degree of achievement of an objective but a measure of a quality, which may aid the achievement of an objective. For example, ability to cross-sell should aid the upgrade to a higher room rate selling to existing loyalty/frequent guests. Note that this ability is already reflected in the output measurement "rooms revenue" and that to include both would be double counting. Another example is service quality. This factor can be considered as influencing productivity (e.g. increased sales) and so, its inclusions along with sales revenue would be a double count.

As a general rule, the DEA model includes all final outputs subject to elimination of the double counting, e.g. variables expected to be highly correlated such as "number of guests with high bad debit reliability". The model should also include intermediate outputs where no final output exists for the objective being measured, subject again to the elimination of double counting. Means to achieving outputs (influencing factors) should not be included but the correlation of each of these variables with the resulting DEA efficiency score should be tested in order to identify its effect on achievement.

The sort of classification used for output factors can also be used for selecting input factors to be included in the DEA model. Thus:
Final input- a direct measure of resources actually consumed in the process of generating the output activities, e.g. staff costs.
Intermediate input - not properly final or influence- an indirect measure of resource consumed. Intermediate input can be used as a substitute in the absence of a final input. For example, the use of a frequent customer program is based on its ability to generate future sales. However, the latter is difficult to measure even if hotels do measure it but the development and maintenance of a customer data warehouse can be an intermediate input to that. Intermediate input can also be used to measure a factor which may influence achievement but whose resource consumption is accounted for by a final input. For example, a variable "in-room internet access" is considered in order to evaluate its influence on achievement, but any resources which the provision of "in room internet access" consumes could be covered by "telecommunication costs" and/or the number of investments in "in-room amenities".
Influence – measure of a factor which may have an influence on achievement but does not consume resources, e.g. "location" of hotel.

Where possible all final inputs should be included in the model, subject to no double counting. Similarly, each intermediate input, for which no final input exists, should also be included – subject to no double counting. The interest with intermediate and influencing variables is usually to test if they do have the desired influence in achievement. If the latter is true, they are included in the model.

The inclusion of influencing variables or elsewhere stated as uncontrollable/discretionary/environmental or external factors has also been argued by other authors as well and several examples can be found. For example, DEA studies in banking have included as an input variable the presence of competitors in recognition of their impact on business potential in the catchment area of the branch (Avkiran, 1999, p.209). Clawson (1974) included a block of seven variables in a pretest list under the heading of competition block; examples from this block are number of competing facilities, population per facility, and market share of competitors. Olsen and Lord (1979) measured the number of competing branches in the area and list it under supply variables. Doyle et al. (1979) examined the number of competitive banks within different distances from the branch, and the number of banks with more attractive facilities, defining what they call the competitive situation. Athanassopoulos (1998) used "branch outlets in the surrounding area" as the measure of competition and concluded that it is likely to be negatively correlated with some outputs (e. g. deposits) and positively correlated with others (e. g. loans). This apparently contradictory observation was explained by acknowledging that the branch in question could have benefited from the customers of competitor banks. Numbers of teller windows and staff represented the resources expended in branch configuration to serve the customers and provided the person-to-person contact for creating selling opportunities. In the DEA literature, Tulkens (1993) also used teller windows as input. Other DEA publications have used staff numbers (FTE) as an input such as Sherman and Gold (1985) and Parkan (1987).

Banker and Morey (1986) argued that the distinction of inputs into controllable and uncontrollable facilitates an analysis where performance can be interpreted in the context of uncontrollable environmental conditions. In practice, failure to account for environmental factors is likely to confound the DEA results and lead to unreliable analysis. Norman and Stoker (1991) argued that DEA models not incorporating environmental/demand factors measure efficiency of processes, while DEA including them reflect market efficiency, i.e. the ability of a firm to control the efficiency of its processes while also making a profit given the environmental circumstances that it operates within.

Dyson, Thanassoulis and Boussofiane (1990) also argued that a key aspect of DEA is incorporating environmental factors into the model as either inputs or outputs. They (1991) went to advocate that one approach to incorporating environmental factors is to consider whether they are effectively additional resources to the unit in which case they can be incorporated as inputs or whether they are resource users in which case they may be better included as outputs.

Avkiran, (1999, p.210) identified two main approaches to incorporating uncontrollable or non-discretionary inputs in DEA. As part of the single stage adjustment, the uncontrollable input can be included in DEA in such a manner that it does not actually enter the calculation of the efficiency score for DMUs (i.e. it becomes a constraint in linear programming). However, this approach suffers from inflated efficiency scores as more constraints enter the linear program. On the other hand, the multiple stage approach can entail a number of methods. A common practice in this case is to run DEA where all the inputs are treated as controllable and then regress the emerging efficiency scores on non-discretionary inputs.

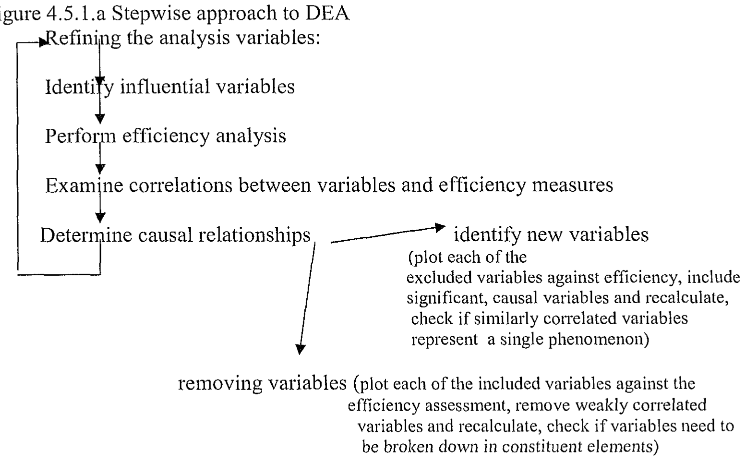
However, whatever the case, a useful practice before embarking on any approach is to regress the inputs on outputs in an effort to find out about the direction strength of the relationships (Avkiran, 1999). Some other authors (e.g. Chen, 1997) argued the conduct of an isotonicity test, i.e. the positive direction of the relationships between inputs and outputs, for determining whether inputs/outputs should be included. The rationale is that because the DEA model requires definitions/selections of inputs and outputs so that when the inputs are added the outputs will increase, only when all the correlation coefficients between inputs and outputs are found to be positive can the inputs and outputs be included in the DEA.

Categorisation of inputs/outputs would not though solve the problem of which of them to select, specifically when there are a lot and the sample size is limited. Basically, an optimum number and type of inputs and outputs is desired because if one more input or output is added in the DEA model it will decrease the discriminatory power of the efficiency score (Boussofiane et al, 1991) by increasing the number of DMUs with 1.00 efficiency score. To that end, a stepwise DEA has been proposed and used in the literature (e.g. Avkiran, 1999).

The stepwise approach to DEA is based on the stepwise regression which was introduced by Sengupta (1988). The objective of the analysis is to identify factors which influence unit performance and to construct a single robust measure of efficiency, which takes these factors into account and so, enabling the determination for each unit of the level of resources which should have been incurred given the level of output it achieved.

The stepwise approach is an iterative procedure in which efficiency is measured in terms of the important factors identified up to that step (Figure 4.5.1.a). Other important factors are identified by examining factors that correlate with the measure of efficiency and applying judgments in terms of cause and effect. Then, these factors are incorporated into the efficiency measure and the process is repeated until no further important factors emerge. At that stage, a measure which accounts for all the identifiable factors which influence performance is constructed.

Figure 4.5.1.a Stepwise approach to DEA



Source: Trait, 1999

Norman and Stoker (1991) used the stepwise DEA approach for constructing a robust DEA efficiency metric based on costs and revenues. Specifically, the question was whether costs and revenues had to be broken down into their component parts. To that end, a stepwise DEA was used whereby aggregate metrics were divided into their components parts in case the latter were found to influence efficiency scores. Analytically, at the first stage a DEA model based on aggregated costs and revenue metrics was constructed. By running this DEA the efficiency scores were calculated which were then correlated with component parts of costs and revenues. In cases where significant correlations were found and based on judgement of cause and effect, factors (i.e. component parts) determining efficiency were identified. The latter were then incorporated into the DEA model (and so their value had to be deducted from aggregate metrics in order to avoid double count) and the process was repeated until no further important factors emerged. At that stage, a robust DEA metric was constructed that counted for all the identifiable factors influencing performance.

In their study, Parkin and Hollingsworth (1997) also proposed and used a stepwise DEA approach by doing correlating potential variables with DEA efficiency scores in order to validate and get their DEA model specification.

A stepwise approach also helps to interpret why particular units are efficient. A table of the efficiency scores of the units at each step can be produced whereby the efficient units introduced at each step can be separated. Basically, the units found to become efficient from one step to another are efficient because of the incorporation of the respective inputs/outputs in the step they were found to be efficient. The bigger the number of factors (inputs/outputs) that can influence efficiency the more units are found on the efficiency frontier, simply because each unit will be efficient in one of the additional factors.

On the other hand, a backward elimination method can also be applied in order to determine the outputs and inputs of the DEA model. This is also based on the stepwise regression analysis and the procedure is as follows (Weber, 1996, p. 44). First, DEA is conducted on designated output and input items and calculate the efficiency score and slack coefficients between non-zero slacks and efficiency scores. Second, the minimum figure corresponding to input/output items is deleted. Third, the procedure is repeated until the desired input/output items are accepted. However, this technique is more complicated and requires a large number of DMUs to start with.

4.5.2 Selection of measurement units of inputs and outputs

Andersson's (1996) study showed that *the choice of measurement units seems to have a stronger effect on performance measures than the choice of items*, which was verified irrespective of the way that inputs/outputs were related, i.e. ratio analysis or DEA. Coupled with the fact that different measurement units provide different information and results, Andersson (1996) concluded that the use of DEA analysis should take into considerations the difference between the different measurement units in order to account for the distinction between the two approaches to productivity measurement, i.e. the narrow and the total factor approach. More specifically, he argued that measures based on quantitative metrics, such as number of guests per day, number of FTEE, reflect the narrow economic sense of productivity, (i.e. resource efficiency), while measures such as value added, salary per month, refer to a broader view that he called "goal productivity" and which describes how well a process is able to achieve its ultimate goal. Thus, effectiveness is also incorporated within the "goal productivity" concept since goal attainment refers to effectiveness.

Overall, the ability of DEA to include several output as well as input variables does not eliminate the need for discussion of the validity and relevance of performance assessment. In that sense, DEA does not eliminate the problem of the identification and appropriate interpretation of measurement units and so, this should then be addressed in DEA models in the same way as using other analytical methods. However, because the use of different measures is able to give different results, it is clear that the selection of appropriate input/output measures becomes more critical.

4.5.3 Ways of analysing inputs with outputs

In running DEA, the analyst has to take three key analysis decisions namely the method of optimisation, the assumption about the nature of returns to scale for the DMUs and weight restrictions on variables.

Optimisation mode refers to the choice of the objective function in the linear programming behind DEA. Because of the duality of the linear programming method behind DEA, two optimisation modes exists namely, input minimisation and output maximisation from which one should be selected.

Input minimisation (also known as input contraction) examines the extent inputs can be reduced while maintaining output levels. This option may be particularly attractive to the analyst when cost reduction strategies are in place or downsizing is planned (Avkiran, 1999). Under output maximisation, the results may suggest raising outputs and reducing inputs (i.e. input slacks). So, input reduction implies over-utilised inputs.

Alternatively, output maximisation (also known as output orientation or expansion) investigates the extent outputs can be raised given current input levels. Output maximisation is argued to be particularly appropriate when management is interested in raising productivity without necessarily reducing resource usage (Avkiran, 1999). Competitive conditions may force management towards that objective. Under input minimisation, potential improvements indicated by DEA may suggest increasing one or more of the outputs while lowering the inputs. Such output slacks depict outputs that are under-produced.

The analyst is also concerned with the nature of returns to scale that could best reflect the operations of the DMUs in the sample. Constant returns to scale (CRS) have been an assumption until late 1980s. Variable Returns to Scale (VRS) began gaining ground soon after its introduction by Banker et al (1984), (Avkiran, 1999, p.211).

A sensible approach for selecting between CRS and VRS is to run the DEA model under CRS and VRS and compare the efficiency scores. If the majority of the DMUs emerge with different scores under the two assumptions, then it is safe to assume VRS. Put another way, if the majority of DMUs are assessed as having the same efficiency under both methods, one can work with CRS without being concerned about scale inefficiency confounding the measure of technical efficiency (Avkiran, 1999, p. 212). However, a more sound way would be first to calculate efficiency scores assuming constant returns to scales and then correlate them with a variable reflecting operating size, e.g. number of staff employed. If a significant negative correlation coefficient is found then decreasing returns to scale (DRS) should be assumed (Avkiran, 1999).

The following should also be taken into consideration. On average, the efficiency ratings obtained under variable returns to scale are higher than those obtained under constant returns to scale, indicating in all cases the presence of scale inefficiencies. Input minimisation and output maximisation yield the same relative efficiency scores under CRS if all the inputs are controllable. However, the introduction of a non-controllable input brings new constraints to input minimisation and leads to different efficiency scores. Input minimisation and output maximisation under VRS yield different relative efficiency scores from input minimisation and output maximisation under CRS.

Weight restrictions to inputs/outputs should be very carefully used because as previously analysed such practice can decrease the discrimination power of DEA.

Avkiran (1999, p. 129-130) provided an all-inclusive checklist for applying DEA:

- Define the decision-making unit to be studied;
- Identify the business drivers (outputs) critical to success of the DMU;
- Identify the key inputs supporting business drivers, e.g. by a process analysis;
- Check if data on the key outputs/inputs are regularly and consistently collected;

- Identify whether there is a particular angle from which efficiency should be analysed, i.e. service volume, overall efficiency, quality only etc.
- Determine the main objective input minimisation or output maximisation;
- Check if there is evidence of VRS;
- Check whether inefficient units measured as efficient when using another method; if so, determine why, e.g. environmental factors have taken into consideration.

4.6 Analysing DEA results

In applying DEA, apart from calculating a single efficiency score the following further analyses can also be conducted.

Scale efficiency scores and the nature of returns to scale for each DMU can be identified and measured either automatically through a software application or manually. If the second option is selected then in order to determine whether a unit operates under IRS, DRS or Optimal Returns to Scale (ORS) the following procedure can be used. DEA is computed under VRS and CRS. DEA is then repeated with non-increasing returns to scale (NIRS) and efficiency scores are compared. It should be noted that, by definition, CRS implies CRS or DRS. So, if the score for a particular DMU under VRS equals the NIRS score, then that DMU must be operating under DRS. Alternatively, if the score under VRS is not equal to the NIRS score, this implies a DMU operating under IRS (Coelli et al., 1998). When the VRS score equals the CRS score, then the DMU is said to be operating at optimal returns to scale (ORS) or the most productive scale size.

DEA creates a list of units in descending/increasing order of relative efficiency. Moreover, caution is required in interpreting such sorted lists because DEA does not truly rank order a branch against all other branches in the sample (Sherman, 1988). DEA identifies a branch as either efficient or inefficient (with varying degrees) against others in its reference set. Theoretically, only those branches with identical reference sets can be strictly rank ordered. Such a situation exists when only one of the DMUs in the sample is 100% efficient. More significantly, rank ordering moves the analyst away from the real value of DEA, that is, identifying potential improvements. Also, rank ordering becomes particularly unreliable when efficiency scores are very close to each other or there are slacks (Avkiran, 1999, p.212).

However, several other analyses have been proposed for clustering DMUs based on their efficiency score. For the efficient units, the following analysis can also be done. DEA identifies the number of units for which each unit on the frontier (with a score of 100%) is a reference unit. This measure is called "frequency" and it allows to gauge each reference unit's importance in setting the efficiency standard and the range over which it influences the standard. The frequency represents the robustness of the DMU compared with other efficient DMUs. The higher the frequency the more robust the DMU is. Thus, there is a single list, crudely, the best units at the top and the worst units at the bottom. Frequencies are used in order to identify the global leader of the sample, i.e. the DMU that most frequently appears in reference sets (Avkiran, 1999, p.212). The benefit of this information is that the management now has an efficient branch that can be emulated in raising the performance of inefficient branches.

However, benchmarking at the individual DMU level is best served by identifying the efficient DMU that contributed the most to the calculation of the efficiency score for the inefficient DMU and then comparing the latter with the former. This is known as the efficient DMU with the highest lamda or peer weight. This more refined approach to benchmarking leads to less resource intensive onsite audits that can generate practical information about productivity improvement (Avkiran, 1999, p. 212).

As concerns inefficient DMUs, the reasons for their inefficiency can be investigated. DEA can so estimate and identify potential improvements for each inefficient DMU and in this way DEA can help in better resource allocation. An overall slack analysis can be done, which can also be broken down in terms of specific outputs and inputs. Average improvements can also calculated. In order to cross check these results non-zero slack for each input/output can be measured. Non-zero slack identifies the marginal contribution in efficiency score with additional specific input amounts. Thus, inputs/outputs with the most non-zero slack can contribute more in improving efficiency than inputs/outputs with less non-zero slack (they are already used relatively efficiently), in other words the determinants of efficiency are ratios with zero slack constrains.

Having calculated frequency scores efficiency lists can be split into four main groupings (Avkiran, 1999):

1. *the robust efficient units*. These will appear on many reference sets and are likely to remain efficient unless there were major shifts in their fortunes.
2. *the marginally efficient units*. These will appear on only one or two reference sets (including their own) and would be likely to drop below 1.0 if there was even a small drop in the value of an output variable (or a small increase in the value of an input variable);
3. *the marginally inefficient units*. These will have an efficient rating in excess of, say, 0.9 (but less than 1.0) and could soon raise their score towards 1.0.
4. *the distinctly inefficient units*. With an efficiency score of less than 0.9, these units would have difficulty in making themselves efficient in the short term. Those with scores of less than say, 0.75, would remain inefficient until there was a major change in circumstances.

Units in the first group can be held as exemplars of good practice. They will be managing their resources, in their operating environment, to great effect. Those in group 4 are clearly not succeeding in this area and provided care has been taken to equalise any effects not covered by the chosen factors, questions must be asked about the management of the units. A unit in the second group appearing on no reference set other than its own is likely to have an unusual data set and is clearly different from the other units. In such a case, a close look at the unit is called for, to establish whether or not there are certain characteristics that mark it out as too different from the other units to be properly compared with them. It might also be the case that the unit is also working to different priorities and, as such, should be investigated.

However, in order to have a smaller number of groups of units in his study, Chen (1997) categorised inefficient units into two subgroups using the median of the efficient scores to isolate the worst libraries among the inefficient ones. Eventually, his analysis had three groups, efficient, above the median and below the median units. Such an approach is more appropriate when sample sizes of DMUs are small.

4.7 Studies using DEA

DEA has been used to assess productivity in a number of types of applications. The focus of the original work of Charnes et al (1978) was on decision- making by "not-for-profit" entities. It concentrated on multifactorial problems (particularly with reference to outputs) and could discount economic weighting factors such as market prices. However, since 1978 numerous researchers have shown that the DEA approach is applicable to the private as the public sector.

The majority of empirical studies are found for industries in various service sectors:

1) in medical services (Nyman and Bricker, 1989; Morey et al, 1990; Valdamis, 1992; Banker et al, 1998; Lohgren and Tambour, 1999);
2) in educational institutions (Charnes et al, 1981; Tomkins and Green, 1988; Ahn and Seiford, 1990; Ray, 1991; Doyle et al, 1996; Hanke and Leopoldseder, 1998; Sarrico and Dyson, 1998; Grosskopf et al, 1999);
3) and in other forms of public authorities or services (Lewin and Morey, 1981; Nunamaker, 1985; Charnes et al, 1985a; Banker, 1989; Schinnar, 1990; Ganley and Cubbin, 1992; Thanassoulis, 1995; Ruggiero, 1996; Worthington, 2000);
4) in banking (Ferrier and Lovell, 1990; Charnes et al, 1990; Barr et al, 1993; Barr and Siems, 1997; Yeh, 1996; Siems and Barr, 1998; Golany and Storbeck, 1999; Kantor and Maital, 1999; Maital and Vaninsky, 1999; Soteriou and Zenios, 1999; Thanassoulis, 1999; Zenios et al, 1999; Chen, T.Y. and Yeh T.L., 1998; Rangan et al, 1988; Berger and Humphrey, 1990; Oral and Yolalan, 1990; Berg et al, 1991; Resti, 1994; Hassan et al, 1990; Yue, 1992; Childs et al, 1996);
5) in retail stores (Thomas et al, 1998);
6) in mutual funds (Morey and Morey, 1999);
7) for investments in information technology (Shafer and Byrd, 2000); benchmarking of computer hard- and software (Doyle and Green, 1994);
8) the control of electricity power plants (Thanassopoulos et al, 1999).

The technique has also been used successfully in such environments as hospitals, universities, airports, farms, libraries, military and government (e.g. Bessent and Bessent, 1980; Sherman, 1981; Lewin et al., 1982; Charnes et al., 1985; Thanassoulis et al., 1987; Tomkins and Green, 1988; Doyle and Green, 1991; Gillen and Lall, 1997; Manos and Psythoudakis, 1997; Raab and Lichty, 1997; Sarrico et al., 1997; Chen Tser-Yieth, 1997; Junoy, P.J., 1997). Relatively rarely publications on DEA applications appear for manufacturing industries (Kamakura et al, 1998; Schefczyk, 1993; Westermann, 1996; Hawdon and Hodson, 1996; Chandra et al, 1998; Al-Shammari, 1999; Caporaletti et al, 1999). A book by Charnes et al. (1994) provides a good discussion of a variety of DEA models based on different industries.

The variety of applications clearly shows the wide appeal of DEA. Still, while efficient frontier methods have been used extensively in research found in other literatures, little research exists that examines efficiency in the tourism and hospitality industry using DEA. Hruscha (1986) and Banker and Morey (1986b) were the first to apply DEA to the hospitality industry. In analysing the panel database of the Austrian Society for Applied Research in Tourism, Hruschka (1986) proposed and studied a form of efficiency measurement on an aggregated level rather than on an individual, company level. In performing DEA for ten different restaurant groups, differences in efficiency among them were found.

Andersson (1996) introduced another application of DEA for the measurement of restaurant productivity. Six variables were used to assess various ways of conceptualising productivity: two output variables including number of guests per day and monthly value added and four input variables including FTEE, salary per month, number of seats in the restaurant and monthly fixed costs.

Bell and Morey (1994; 1995) introduced DEA for the use of benchmarking to discover best practice solutions in corporate travel management. Their results showed that firms were 83.9% efficient, which implies that 16.1% of the total costs being incurred for corporate travel could have been saved if the firms were efficient.

There have been only few reports of DEA's use in the hotel sector. Morey and Dittman (1995) gathered input-output data for 54 hotels of a national chain in the USA and by using data for each individual hotel, they applied DEA to generate a "composite efficient benchmark general manager". The latter acts as a scorecard for the hotel under review so they (1995) stressed the usefulness of the DEA technique in the evaluation of franchising relationships which are commonly used in the hotel sector. Their findings showed that managers were operating at 89% efficiency, i.e. given their output, managers on average could reduce their inputs by 11%. The study also reports that the least efficient hotel was 64% efficient. However, additional evidence seems necessary as Morey and Dittman (1995) characterise the market as efficient, while Baker and Riley (1994) suggested that high levels of inefficiency are present in the industry mainly due to the limited management skills. Morey and Dittman (1995, 1997) applied DEA for selecting a hotel property. Their model combined DEA and regression analysis and aimed at maximising the expected value of annualised profits given brand, design and operational choices.

Johns et al (1997) used DEA to monitor and benchmark productivity in a chain of 15 hotels. Data for a 12 months period was used from which quarter results were compared with each other and with standard accounting data for the same period. In developing their DEA model, they used simple inputs and outputs, no ratios or composite data were employed, and non-financial data was preferred. Specifically the following three outputs and five inputs were used: a) outputs, number of room nights sold, total covers served and total beverage revenue and b) inputs, number of room nights available, total labour hours, total food costs, total beverage costs and total utilities cost. Their findings showed that: a) hotels appeared to perform with very similar efficiency, with the majority clustering around the "optimum" position; b) no consistent pattern of efficiency-profitability between the three size groupings of hotels was found; and c) no tendency to place hotels of similar room numbers together in the same reference groups was indicated. The latter indicated that some other criterion, such as location or managerial effectiveness may have been responsible for differences in hotel performance. Overall though, research findings indicated that DEA is useful for diagnosing and identifying outstanding behaviour in terms of their measured productivity and gross profit.
Similar to Johns et al (1997), Avkiran (1999) used seasonal time series data for a small set of Australian hotel companies (23 units) in a case study and applied window DEA to measure and identify areas for productivity improvements across time.

Anderson et al (1999a) used a stochastic frontier analysis in order to measure the performance of 48 hotels taking into consideration four outputs (total revenue generated from rooms, gaming, food and beverage and other revenues) and five inputs (number of full time equivalent employees, the number of rooms, total gaming related expenses, total food and beverage expenses and other expenses). Their results did not differ from those by Morey and Dittman (1995) apart from the fact that the slightly higher efficiency scores were expected because of the differences in the estimation techniques employed (Morey and Dittman did not use a stochastic DEA and so inefficiencies due to errors were not considered). However, the comparable high efficiency scores taken when using both these techniques provide stronger evidence concerning the structure and the performance characterised in the hotel sector market.

In their proposed model for applying and assessing Total Quality Management (TQM) in the hospitality industry, (the HOSTQUAL), Christou and Sigala (2001) proposed the use of DEA for benchmarking TQM strategies either across hotels or across time. Specifically, the DEA methodology was proposed for measuring and testing the HOSTQUAL's constructs, because the former can identify the areas (i.e. constructs) where improvement is required, which in turn can foster continuous improvement. Indeed, in a later paper by collecting data from TQM practices employed by Greek hotels, Sigala and Christou (2001) provided empirical evidence of the validity of the HOSTQUAL model and the use of DEA for benchmarking TQM practices. Moreover, as likert scales were used for measuring the HOSTQUAL constructs, their (2001b) study also illustrated how DEA models can be applied and interpreted when DEA variables are measured in non-financial metrics.

4.8 Summary

DEA is a multivariate linear programming technique that derives from the production function concept. It can be used in order to benchmark and measure the performance of any system once its inputs and outputs are defined. Several examples of the use of DEA have been provided. DEA represents several advantages for measuring productivity relative to other techniques, while it has several additional extra features. DEA results can be easily interpreted and complemented with other traditional techniques. However, DEA is as good as the process with which is applied. Thus, a rigorous process should be taken in order to identify and use: a) the inputs and outputs that will include (a stepwise approach will be used in this study); b) the measurement units of inputs and outputs (financial aggregate units reflecting all productivity dimensions are used); c) the way data are analysed (hypotheses and assumptions are checked while DEA is used, e.g. assumption of constant or variable scales of return).

The study could have also applied the group approach to DEA as previously analysed in order to identify the effect of particular ICT metrics on hotel productivity. Hence, groups could consist of hotels with different level, type and use of ICT investment. Such discrimination of hotels would have allowed the identification of the impact of different ICT management practices on hotel productivity and thus, give useful guidelines. However, because the number of hotels that could have been clustered into groups with similar ICT configuration would have been proportionally small relative to the selected inputs and outputs, the analysis of the study did not went further in assessing and calculating the impact of different ICT configurations on hotel productivity. Instead, the study used DEA in order to identify the productivity frontiers and scores of hotels in the sample and then use inferential statistics in order to investigate whether productivity levels relate to ICT metrics.

CHAPTER FIVE

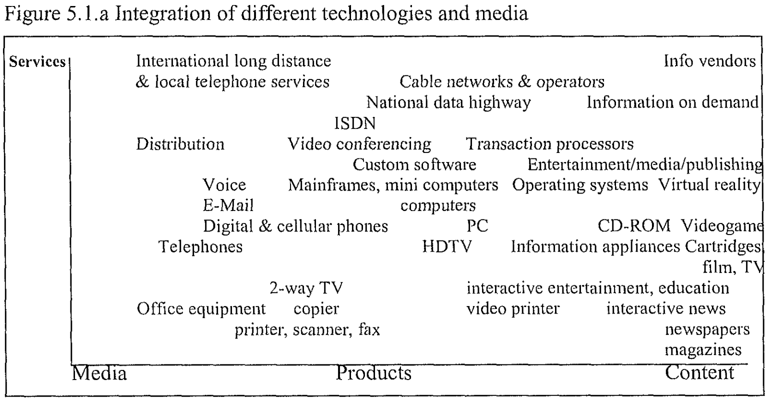
Defining and measuring ICT

In reviewing the productivity concept, it was suggested that two issues regarding ICT might affect productivity the ICT assets and resources and the ICT applications. In this vein, this chapter aims at defining and measuring these ICT concepts. To that end, the first part concentrates in analysing the ICT tools and capabilities, how they have evolved during time and how they impact productivity by extending the asset frontier. The second part focuses on analysing and reviewing theories from different approaches regarding how the use of ICT, i.e. the ICT applications, can increase productivity by impacting on the operating frontier. However, as these approaches present some limitations, an overall framework that more rigorously capture the way ICT applications impact on productivity is proposed. Based on this framework a model of measuring ICT applications that can be directly related to ICT productivity benefits is finally developed and argued.

5.1 Defining Information and Communication Technologies (ICT)

Werthner and Klein (1999) defined ICT as the tools, skills and knowledge needed to process information electronically. This general definition covers hardware, software, netware and humanware that comprehends methods and tools to analyse, design, implement, evaluate and use computer systems. However, a continuous and increasing convergence between hardware devices/media (e.g. computers, PDAs, mobile phones, digital TV etc) as well as software standards that allow interoperability, content/databases dissemination and creation of networks has been going on transforming our economy from an atom based to a digit based approach (Negroponte, 1995). Such a convergence is not astonishing since microprocessors are universal symbol-manipulating machines and so, any media and software that can be represented in the form of digital symbols can be delivered through digital networks. Figure 5.1.a illustrates how the computer is enabling convergence and integration between technologies and so, lowering the boundaries between related ICT industries.

Figure 5.1.a Integration of different technologies and media



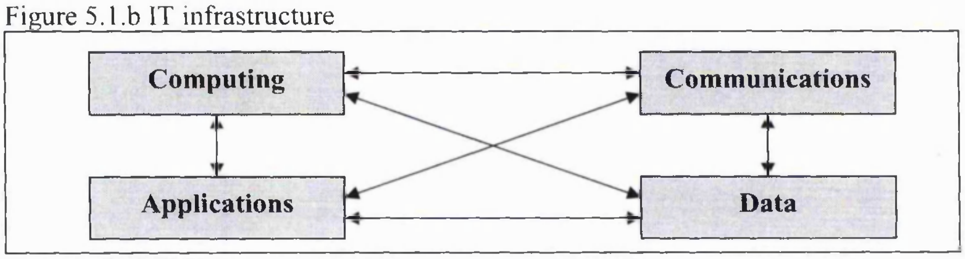
Source: Manasian (1993)

Because of the increasing standardisation, integration of systems and data and diffusion of ICT throughout the business, Ciborra (1998) argued that the concept of business IT infrastructure emerged in the 80s in order to emphasise the need and provide a way to reconcile the centralised IS department, resources and stand alone localised systems on the one hand and the distribution of systems and applications on the other. Indeed, nowadays, managing IT to deliver an effective capability means dealing with problems such as: aligning strategy with IT architecture and key business processes information requirements (Henderson et al, 1996); universal use and access of IT resources; standardisation/interoperatibility of systems and applications through protocols and gateways; flexibility, resilience and security (Hanseth, 1996). Ideally, the IT infrastructure should reconcile the local variety and proliferation of applications and usages of ICT with centralised planning and control over ICT resources and business processes (Broadbent and Weill, 1997; Hanseth, 1996).

In this vein, Earl (1989, p.75) defined IT architecture as *"the technology framework, which guides the organisation in satisfying business and management information needs... IT architecture is the frame work for analysis, design and construction of the IT infrastructure which guides an organisation over time"*. The IT infrastructure comprises four interdependent elements (Figure 5.1.b), meaning that not only is architecture seeking to achieve an infrastructure that is greater than the sum of the parts, but each element influences the other (Earl, 1989, p. 95):

1. computing – the information processing hardware and its associated operating system software. It comprises mainframes, microcomputers, process control computers, workstation terminals, peripherals, etc.
2. communications – the telecommunications networks and their associated operating mechanisms for interlinking and interworking. For example, LAN, WAN, Internet, Intranet, Extranet etc, that not only transport data, voice, text, image around their organisations efficiently and reliably, but increasingly, they are communicating with outside organisations such as customers, suppliers
3. data – the data assets of the organisation and the requirements of use, access, control and storage. Data is the most important element as it is the raw material of information and thus in a sense both the means and ends of information systems.
4. applications – the main application systems of the organisation, their functions and relationships, as well as the development methods. Applications are a crucial element of architecture because organisations need a map or blueprint through which to plan development and anticipate the requirements of computing, communications and data.

Figure 5.1.b IT infrastructure

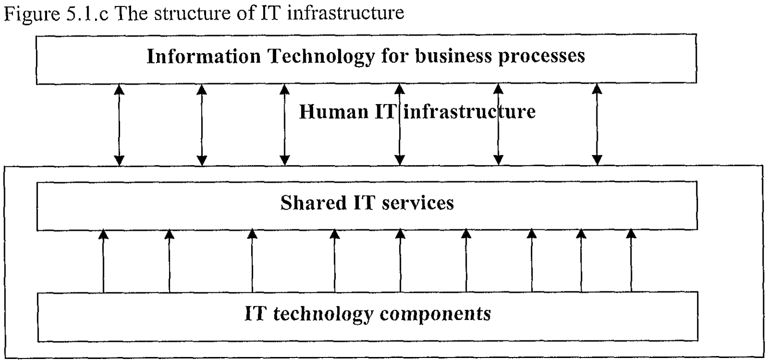


Source: Earl, (1989)

Literature also distinguishes between firm-wide and business unit infrastructure. Firm-wide infrastructure is shared across all the business units and is provided by the corporate IT function. Business unit (local) infrastructure is shared by the functional areas in one business unit and may be provided by the business unit of the corporate IT function. Other definitions of IT infrastructure are provided below, which highlight the same issues as that of Earl (1989) and incorporate the human element as well.

According to Turnbull (1991) the IT infrastructure includes the hardware, operating software, communications, other equipment and support required to enable business applications. McKay and Brockway (1989) argued the need for a mortar to bind all the IT components into robust and functional IT services that make up the infrastructure. This mortar includes a specific body of knowledge, skill sets and experience that provide the policies, planning, design, construction and operations capability necessary for a viable IT infrastructure and is referred to as human IT infrastructure. To that end, they (1989) proposed a useful model of IT architecture incorporating the human elements (Figure 5.1.c). The IT infrastructure is composed of two layers. At the base are the IT components (e.g. computers), i.e. the commodities readily available in the market place. The second layer above is a set of shared IT services such as universal file access, electronic data interchange (EDI). The IT components are combined into useful IT services that can be used as building blocks for business systems. The human IT infrastructure of knowledge, skills and experiences moulds these two levels together into the firm's IT infrastructure.

Figure 5.1.c The structure of IT infrastructure



Source: McKay and Brockway (1989) in Banker et al, 1993

Peacock (1995) also argued that dictionary definitions of technology also include three interrelated dimensions as follows: the technology, i.e. the artefacts that one can touch, feel and use to do his job, e.g. monitors, printers keyboards as well as software; the skills and knowledge enabling the use of those artefacts i.e. pieces of equipment that could range from basic to higher strategic level skills; and the organisational context of the use of the machine, the power relationships that decide how one uses that piece of equipment and skills. So, for example the technology of a pen would be the pen itself, the skill that enables you to use it (i.e. writing), as well as the use to which it is being put. In this vein, when studying the pen, one could not separate the physical reality of the pen from the use people make of it, while this tripartite division of technology - artefact/skill/context – is just as important when looking at hotel companies (Peacock, 1995). Head office may decide to buy a piece of equipment but how this is going to be used or whether staff is going to be provided training on how to use it are other important issues that have to be examined, because only when the three dimensions are in harmony can a technology work successfully.

Kirk and Pine (1998) also highlighted that definitions of technology that can have the most relevance to hospitality should incorporate the human element, since technology cannot be considered in isolation of people, both those within the organisation together with clients and customers. To that end, Pine (1997) gave a hospitality based descriptive definition of technology that includes the skills, knowledge and methods for achieving plans in a changing environment, and which so encompasses management systems and techniques as well as the physical artefacts of technology, such as equipment and machines.

Renkema (1997) also argued that traditionally the notion of the IT infrastructure had a rather narrow, technological connotation, generally referring to the centralised computing equipment, which encompassed all technological means as well as the personnel and organisational procedures in the IS department. For example, a definition of infrastructure falling within this view is the one by Weill (1993, p. 345 in Banker et al, 1993): "*the base foundation of IT capability budgeted for and provided by the information systems function and shared across multiple business units and functional units. The IT capability budgeted for includes both the technical and managerial expertise required to provide reliable services*".

In his research on managing the impact of IT infrastructure, Renkema (1997) argued that it is useful to make a distinction between indirect and direct infrastructure (Table 5.1.a). Indirect infrastructure includes the technological and organisational facilities, such as processing equipment, data-communication tools, system developers and operations personnel. The indirect infrastructure enables the use of the direct infrastructure that comprises the infrastructure of databases, application systems and knowledge bases. Renkema (1997, p. 140) argued that as "*the direct infrastructure is generally to a large extent integrated with the business processes and the products and services of the organisation, by providing direct information processing capabilities, ... the benefits of the direct infrastructure are therefore much more related to business improvements than the benefit of the indirect infrastructure*".

Table 5.1.a Direct and indirect infrastructure

Direct infrastructure	**Indirect infrastructure**
Focus: Integrated with the business processes and products/services of an organisation	*Focus:* Enables the use of IT in business processes and products/services of an organisation
Objects: Manifests itself in shared IT applications, databases and knowledge bases	*Objects:* Manifests itself in shared technological and organisational facilities
Character: Demand: uses/facilities of indirect infrastructure	*Character:* Supply: offers facilities to the direct infrastructure

Source: Renkema (1997)

The concept of ICT has also been defined by authors adopting a resource base theory of the firm. In this vein, a firm's IT capability was defined as "*its ability to mobilise and deploy IT-based resources in combination or copresent with other resources and capabilities*" (Bharadwaj, 2000, p. 171). This is compatible with the long term arguments of sceptics of IT's direct value on firm performance supporting that firms benefit from IT only when IT is embedded in the organisational structure producing valuable, sustainable resource complementarity (Clemons, 1986; Clemons and Row, 1991). Thus, ICT are viewed as a resource, which is expected to generate competitive value only when it leverages or enables pre-existing firm resources, which is clearly in line with the strategic alignment principle (Henderson and Venkatraman, 1993).

Specifically, resource base theorists classify IT-based resources whose interactions can create an IT capability under three categories namely, physical IT infrastructure (measured as reach and range, Keen, 1991), the human IT resources (comprising both technical and managerial skills) and intangible IT-enabled resources such as knowledge assets, customer orientation and synergy. The IT infrastructure provides the platform to launch innovative IT applications, the human resources enable firms to conceive and implement such applications while IT-enabled intangibles leverage or exploit pre-existing organisational intangibles, e.g. customer orientation and synergy.

Thus, the contribution of this perspective is that it emphasises the role and value that the element "information" plays within the ICT concept. As Strassmann (1998) argued studies of IT have given too much emphasis to the word "technology" rather than "information". On the other hand, previous definitions emphasising the shared and co-ordinated features between work-stations, functions, people and organisations, enabled and fostered by ICT and their convergence, mainly highlight the "communication" element of ICT that the concept of IT infrastructure implicitly entails. However, overall, it is evident that irrespective of the definition and perspectives of IT infrastructure, the concept of ICT should stress the increasingly shared, co-ordinated nature of people, resources (tangible and intangible) and procedures/practices in the field of ICT. To that end, an all-inclusive description of the ICT concept should encompass the following three dimensions.

5.1.1 IT infrastructure

The physical IT assets forming the core of a firm's overall IT infrastructure comprise the computer, communication technologies and the shareable platforms and databases (Ross et al, 1996). The IT infrastructure is a shared information delivery base, whose business functionality has been defined in terms of reach and range (Keen, 1991).

Reach determines the locations that the platform can access and to which it can link, e.g. links between work-stations, functional areas within a firm, linking customers and suppliers domestically and internationally. The conceptual ideal of reach is to link to anyone, anywhere. Range determines the breath of information that can be directly and seamlessly shared across the systems. Ideal range would allow any computer generated transaction or document to be used on any other system. The combination of the available reach and range defines the dimensions of the firm's IT infrastructure, while business needs and scope determine the extent of reach and range required.

From an Information Systems (IS) perspective, whereby ICT is viewed as an input-output information processing system, a compatible definition of ICT is provided that recognise its range and reach dimensions. By integrating Anthony's (1965) management activities and organisational functions, Davis and Olson (1985) defined the structure of an IS architecture as follows:

"*a federation of functional subsystems, each of which is divided into four major information processing components: transaction processing, operational control information system support, managerial control information system support and strategic planning information system support*" (Banker et al, 1993, p. 45)

Wetherbe (Banker et al, 1993, p. 86) also argued that the term IS architecture refers to the overall structure of all IS combined, consisting of the applications for the various managerial levels of the organisation (operations, management control, and strategic planning) and applications oriented to various management activities such as marketing, R&D, production and distribution. Laudon and Laudon (1999) classified IS systems supporting the previous four management layers respectively as follows:

a) transactional IS; b) operational IS; c) Management Information Systems (MIS) and Decision Support Systems (DSS); and d) Executive Support Systems (ESS).

Thus, in the same vein as the previous definition, IS diversity in an organisation has traditionally referred to the numbers and types of IS applications developed or present in that organisation, while the number and the type of IS applications is also argued to be affected by a firm's business strategies (Grabowski and Lee, Banker et al, 1993, p. 42). Thus, according to Weill (in Banker et al, 1993, p. 554) the key distinguishing features of infrastructure are as follows:

1. Infrastructure is shared across most functional areas or business units;
2. Infrastructure is budgeted for and provided by information systems function;
3. Infrastructure is typically large, long-term and exploits economies of scale;
4. Infrastructure is the basis for applications supporting business processes;
5. Once in place, infrastructure is costly to change in financial and political terms.

Depending upon these diversity variables and especially the strategic intent of the business, which will denote the particular use of each application/system, IT infrastructure can play different roles: utility, dependence and enabling (Broadbent et al, 1996). As a utility, infrastructure aims at saving costs of processing and communicating information throughout the organisation. Second, the performance of key processes depends upon the infrastructure, e.g. the effectiveness of the reservation process depends on integration of YM, reservation systems etc. As Parker and Benson (1988) argued the value of IT infrastructure is generated by enabling IS to support business processes, but not providing benefits directly. The IT infrastructure underpins business strategic and operational advantage by enabling initiatives such as cycle time improvement, cross-functional processes and cross-selling opportunities (Weill and Broadbent, 1998). Enabling infrastructure provides the platform for new applications, e.g. integration of YM and customer databases enable to yield at an individual customer level (Sigala et al, 2000c).

Keen (1991, p. 184) argued that an IT infrastructure is a major business resource and perhaps one of the few resources of a long-term competitive advantage, since *"it is the IT platform that determines the business degrees of freedom a firm enjoys in its plans"*. A non-integrated IT infrastructure dominated by system incompatibilities can severely restrict an organisation's business choices. For example, the provision of online reservation may require the integration of property based reservation systems which if not available will restrict the capabilities and features of online bookings. Earl (1991) defined the building of this flexibility infrastructure-led strategy. This type of strategy is concerned with providing ICT networks, rationalising data standards and providing a sound foundation for the business systems and has the following characteristics. Capital investment in IT never ceases and the IT strategy cannot be project-based, as integration, dependencies and architecture are important. Finally, the business strategy and the IS/IT strategy become indistinguishable.

Weill (1991) argued that public infrastructure share a lot of similarities with IT infrastructures and so many of the benefits demonstrated from public infrastructure can accrue to IT infrastructure. So, the latter is expected to: improve productivity of and leverage user groups' own IT investment; enable new business needs to be met more rapidly; reduce time to market for new products; enable later business projects at lower cost; and provide organisational flexibility for later and unexpected uses.

The IT infrastructure also provides the resources that make feasible innovation and continuous improvement of products (Duncan, 1995; Venkatraman, 1991), as it enables firms to: identify and develop key applications rapidly; share information across products, services and locations; implement common transaction processing and supply chain management across the business; and exploit opportunities for synergy across business units.

Overall, it is evident that IT infrastructure has no value in itself. However, its value becomes evident when it is embedded with other organisational resources and business processes, in other words when it is being used. To that end, Earl (1989) identified four crucial roles of the IT infrastructure:

1. A framework for designing systems and technology interfaces, compatibilities and integration. The latter is important as technology becomes embedded in business operations and sector infrastructure.
2. A framework for resolving and reviewing technology choices over time. IT infrastructure needs to meet the increasing amount of order in information processing because of the rapid technological changes, the evolution of organisational structures and changing business needs.
3. A framework for implementing the organisational IS needs, i.e. the sets of policies and mechanisms for the effective and efficient delivery of the IT infrastructure.
4. A technological model of the organisation, which is important as the relationship between business and IT strategies and capabilities and IT become closer.

5.1.2 Human IT resources

Human resources generally comprise the training, experience, relationships and insights of employees in two critical dimensions (Bharadwaj, 2000):

- technical skills, such as programming, systems analysis and design and competencies in emerging technologies and
- managerial IT skills, such as effective management of IS functions, coordination and interaction with users and project management and leadership skills.

The human resources are also argued to be one major factor intermediating the relationship between IT spending and economic value. ICT changes how organisations handle information, which in turn is an input to many different business processes, some simple and many quite complex. It is not computers alone that make the difference but the people and work who know what to do with them. Strassmann (1990) argued that business productivity is rooted in well-organised, well-motivated and knowledgeable people who understand what to do with all information that shows up on their computer screens, while Thorp (1994, p. 9) commented that *"if computer expenditures and corporate profits show no correlation, it is a reflection of the human condition that excellence is an uneven occurrence"*.

The adaptability of employees to organisational change is another factor that determines the ability of business to leverage IT functionality (e.g. Gretzel, 2000; Pine, 1987). Clark et al (1997) characterised an organisation's ability rapidly to develop and deploy critical IT systems as its change-readiness capability. For example, in investigating large financial service companies in UK, Watkins (1998) found that established firms felt encumbered by their massive and rigid technological infrastructure of previous decades, but they could not quickly convert to new systems not only due to cost pressures but more significantly because IT staff had a vested interest in preserving the legacy systems and so resisted organisational change. So, IT resources once valuable were rendered obsolete creating competitive disadvantages.

In fact, the wide difference in competitive organisational and economic benefits that companies gain from IT has been attributed largely to their managerial IT resources (Keen, 1993; Mata et al, 1995; Weill, 1988). For example, Keen attributed Federal Express' s commitment to high levels of customer service as a strategy rooted in their managerial IT capability. Sambamurthy and Zmud (1992) found that the managerial ability to coordinate the multi-faceted activities associated with the successful implementation of IT systems was a key distinguishing factor of successful firms.

According to Bharadwaj (2000) the quality of the human IT resources are demonstrated and reflected by their capability to:

- integrate the IT and business planning process more effectively;
- conceive of and develop reliable and cost effective applications that support the business needs of the firm faster than competition;
- communicate and work with business units more effectively; and
- anticipate future business needs of the firm and innovate valuable new product features before competitors.

Indeed, current thought advocates that IT applications are better thought of as the uses (Stinchcombe, 1983) of IT resources or the embodiment (Teece, 1986) of IT resources in new products, new processes, or improved co-ordination and control, and so, IT applications are a major component of IT human resources' knowhow. Because applications are believed as capable of creating direct business value (e.g. Parker et al, 1988; Keen 1991) with demonstrable financial and non-financial results (Banker and Kauffman, 1988; Clemons and Row, 1988), *"the breath and the quality of a firm's portfolio of IT applications is a significant and useful surrogate for the value of a firm's accumulated human IT assets"* (Markus and Soh in Banker et al, 1993, p. 380).

5.1.3 IT enabled intangibles

This dimension of the ICT concept basically develops on the element and deployment of the "information" aspect of ICT. Information has been referred to as the fourth resource after money, people and property/equipment – all of which have their management disciplines. Information is regarded as both a resource/input and a product or better a by-product of ICT and it is generally defined as data with a scope/purpose. However, regardless of its way of conceptualisation, information possesses features and characteristics that sets it apart from physical and tangible products (Masuda, 1990; Kremar, 1997; Wigand et al, 1997; Whinston et al' 1997; Strassmann, 1988; Werthner and Klein, 1999):

- Information is not consumable; goods lose value when consumed, but information appreciates, aggregates or expands with use;
- Productivity increases with an increase in the quantity of goods produced; increasing the information load may diminish information workers' productivity;
- The marginal cost of goods equals its price, but the marginal cost of making another copy of existing information approaches zero as the cost of additional units is minimal;

- The price/value of information has no relation to its marginal cost;
- Cutting a loaf of bread into halves diminishes the value of the loaf, but making copies may not diminish the value of the original;
- Information can be transported at the speed of light;
- But information is no-transferable, even after the transmission of information it is still available at the source;
- Information is non-exclusive; intellectual property rights and copyrights are hard to protect;
- Information is accumulative; it gains value/new qualities through accumulation;
- The value of information is determined by its usage, and specifically information expands through its usage due to network externalities and synergies; as a result its value can hardly be anticipated;
- Information does not depreciate but rather appreciates; i.e. the value of information increases with its use;
- Information is an immaterial good that is not destroyed through multiple usage;
- When evaluating information, the so-called information paradox arises;
- Information can be condensed;
- Information can substitute other economic resources, e.g. reservation systems "replace" room inventory;
- Information is inclined towards diffusion; actually, information is a diffused resource, that enters into all the activities of businesses and forms a component of all products and services that are sold (McPherson, 1994, p. 203).
- Information initiates relationships.

Orna (1996) also identified the conditions under which information can create value:
- Information has to be transformed by human cognitive processes into human knowledge, without which no products of tangible value are produced or exchanged.
- Where inflows of the information necessary to maintain knowledge and support appropriate action are blocked, disaster can follow, either quickly or in the form of a gradual run-down into incompetence and chaos.
- If it is hoarded for the exclusive use of a limited number of people, it can actually fail to achieve its full potential value for those who hoard it, but if it is exchanged, the value resulting from its use increases for all parties to the transactions.
- Information has no inherent value of itself. *"Its value lies in its use"* (Abell, 1993, p. 53) *"value is derived from and is added to by those involved with the process of its transfer"* (Akeroyed, 1991, p. 89)

In other words, information has no value in itself but its value materialises when it is being used for a purpose. Provided that several organisational intangibles such as know-how, customer service and orientation have been recognised as key drivers of superior performance, in the context of information, its value is demonstrated in its enabling role to foster and support applications for creating intangible organisational resources. Several examples and studies have illustrated the latter, for example, Bharadwaj (2000) advocated the IT's enabling role by using three organisational intangibles namely customer orientation, knowledge assets and synergy. However, a more detail analysis on information applications that create organisational intangibles is provided in a following section.

Overall, it becomes evident that whatever the conceptualisation of ICT, its business value is embedded in its use. As Strassmann (1998) argued a computer is worth as much as it can get sold for in an auction. In other words, the business value of ICT is an indirect one dependent on its deployment, with the latter being planned and visioned by the human IT resources. Hence, the boundaries of the ICT concept are determined by two issues namely the ICT tools and their use/application. This is compatible with Schmenner and Swift's (1998) theory of performance frontiers, which advocates that differences in performance can be due to two reasons differences in infrastructure (i.e. ICT equipment), the asset frontier, and differences in management practices (i.e. uses of ICT), the operational frontier.

In this vein, it is clear that in order to analyse the impact of ICT on productivity a discussion and analysis is required on the advancements of ICT tools and capabilities and the management practices and their potential productivity impact that the adoption of ICT tools and capabilities have fostered and supported. To that end, the following sections provide a detailed analysis of frameworks and models that have been proposed to summarise changes and developments in both the ICT asset and operational frontier. The interrelationships and compatibilities between these two types of frontiers is evident and not surprising, since management practices are built on the ICT tools and capabilities that are available (IT push), while management and operational needs also demand and indicate the development of certain ICT capabilities (IT pull).

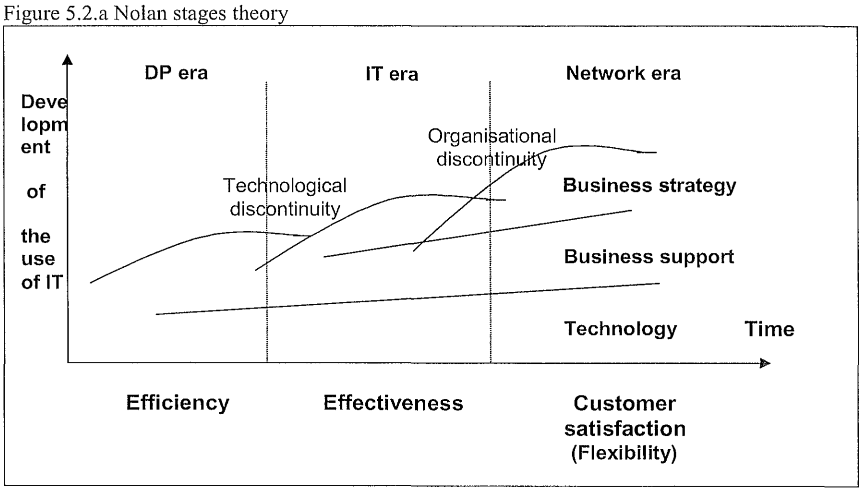
5.2 The development stages of ICT tools and capabilities; extending the asset frontiers

As ICT are an economic resource directly intertwined with other resources and solidly embedded into business processes and operations, it becomes obvious that ICT developments cannot be seen separately. Hence, the framework of ICT developments also provides a model of the changes in management practices that ICT have fostered and supported. Overall the changes that ICT developments have fostered in economy are also summarised in order to understand better and highlight the substantial role that the deployment of all constituent parts of ICT play in the viability and competitiveness of business in the new economy.

ICT has undergone dynamic and continuing rapid development and changes that are driven from two sides. On the supply side, new technologies are emerging rapidly, whilst the business environment increasingly pushes the demand for IT support. There are two well-established frameworks concerned with the development of IT in organisations that are easy to follow as they do not go into technical details.

Nolan (1979) proposed a model describing the growth processes and the development of the use of IT in organisations composed of two eras, namely the Data Processing (DP) era and the IT era. Mutsaers et al (1998) extended this model by adding the Network era (Figure 5.2.a). Each era has its own characteristics in both business and IT terms. The transition from the DP to the IT era is typified by a technological discontinuity while between the IT and the Network era an organisational discontinuity can appear.

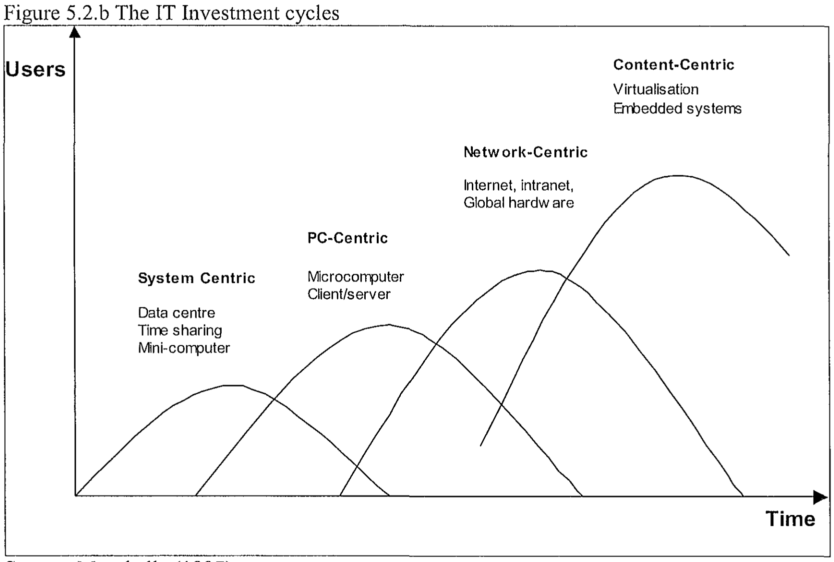
Figure 5.2.a Nolan stages theory



Source: Mutsaers et al (1998)

In the same vein, Moschella (1997) has posited a similar framework, but which outlines four main eras in IT adoption and use, that he calls the System-Centric, the PC-Centric, the Network-Centric and the Content-Centric eras (Figure 5.2.b).

Figure 5.2.b The IT Investment cycles



Source: Moschella (1997)

The descriptions and analyses of the different eras, proposed by these two frameworks, suggest that they have considerable overlap and so they can be summarised in the following eras.

5.3.1 The Data Processing Era (DP era)

Grosch's law, first suggested in the 1990s, is the dominating principle through most of this period. According to this, computer power increases as the square of the cost, meaning that a computer that is twice as expensive delivers four times the computing power. Thus, as computers can process and analyse large complex data sets quickly and accurately, they were mainly used to simplify and accelerate the pace and quality of such work. The data department is mainly involved with the development, maintenance and support of such systems and is leading decision-making in IT. This era is mainly characterised by the fact that management really begins to pay attention to the phenomenon of automation. As, the business environment in the DP era is relatively stable and businesses are typically functionally oriented hierarchies IT is mainly used to improve efficiency (e.g. by replacing humans with machines). For example, in the hotel context, ICT were used in order to automate the reservation process, Sigala et al (2001c), usually through central reservations.

5.3.2 PC-Centric era

It is Moore's law that summarises the underlying IT economics of this era, which simply stated that semiconductor price/performance would double every two years for the foreseeable future. Helped by the constantly improving designs and processing capacities, this prediction remained fairly accurate through the 1990s and thus, many peripherals and PC software tools took on commodity-like characteristics. The relatively low prices for out-of-the-box ICT solutions instead of in-house developments resulted in a rapid and wide technological adoption and diffusion across all hotel operations, e.g. personal computers, new types of personal software (such as spreadsheets and word processors) and the expansion of chip technology in point of sale terminals, data communication networks, and work-stations.

In this era, the business environment was in a state of rapid change and so, companies moved towards process-oriented structures and separate business units organised according to markets, product lines or geographic areas. Technical developments in distributed computing architecture coupled with organisational reactions against local, costly and frequently inefficient microcomputer-based initiatives supported such organisational transformations. There was also a shift towards open systems that promise common standards and high compatibility. Despite the difficulties and the underlying costs of building such an open and integrated ICT architecture, the latter crucially facilitated interfaces between systems and sharing of databases. In the hotel context, an integrated ICT infrastructure meant that systems such as distribution systems, electronic point of sale (EPOS), property management systems (PMS), and YM systems were able to communicate and exchange data between each other and it was in this era that ICT advancements led to the development of the concept and practice of the unit-level YM, Sigala et al (2001c).

Overall, it is a general agreement that environmental circumstances and production tools and practices during these two ICT eras, supported a mass production system whose productivity economics are summarised as follows (e.g. Pine, 1993). Mass production is based on a shared goal between business and consumers. On the one hand, consumers accepted standard products, which in turn facilitated market expansion and reduction of prices through economies of scale. On the other hand, the emphasis on demand from homogeneous markets was further encouraged by businesses' restricted capabilities to produce differentiated products at similar prices to those of mass produced products. Hence, the consumer-producer relationship became institutionalised in a stable market environment.

Mass production is based on an inherent logic that profit is essential if companies are to remain in business (Pine, 1993). Profitability is a function of volume and margin. Margins can be increased if costs are kept as low as possible, the latter is easily achieved through mass production. Homogeneous markets are volume markets, hence an increase in volume decreases costs further and typically, as prices are elastic, price reductions can lead to increased volume and revenues. Further cost reductions can result in price levels at which niche market customers that remain are left to fringe producers, while the remaining niche markets are left to fringe the latter. Producers are applying technology (e.g. automated processes), which increases fixed costs but lower unit costs, while pricing is used to expand volume still further. Product life cycles are long and maintained long in order to ensure that costs can be amortised over large volumes produced and sold. Internally organisations operate a tightly controlled production system that uses incentives to achieve volume targets. Externally distributors accept (prefer) few product changes through a combination of acceptable levels of quality and service at low prices.

5.3.3 The Network era

In this era, not only hardware and software, but even systems and applications all show increasingly a trend leading to integration. Varying computer architectures and system technologies are synchronised to enhance their compatibility and they are built into heterogeneous networks and systems based on their degree of interoperability. Integration and openness are related terms. An open system is a system that can be utilised while following generally accepted and openly accessible rules in conjunction with other systems. The official definition of open systems given by the Technical Committee on Open Systems is as follows:

"... the complete and consistent number of international technology standards and functional standards for the specification of interfaces, services and formats for the assurance of interoperability and portability of applications, data and people". (Bues, 1994, p. 22, adapted from Wigand et al, 1997, p. 125)

Thus, openness is a prerequisite for integration, especially with looking at the integration-determining factors such as interoperability and portability. Interoperability, meaning the cooperation of different components, and portability, i.e. the transferability onto other systems, are two important aspects on the road to integration of ICT infrastructures. In fact, an integrated ICT architecture requires integration at different layers, e.g. application layer, network layer, data link layer etc (Wigand et al, 1997). In other words, an integrated ICT infrastructure demands integration between all its constituent elements, i.e. data, computing, applications and communications. However, in the context of business ICT management and the scope of this research, the technical way of achieving such integration is of no interest. What is important is whether such integration exists or not.

This era is also characterised by the introduction of the Internet and its mass market exposure with the arrival of the Mosaic graphical interface in 1993. As a result, this led to a substantial integration of worldwide communications infrastructure and general purpose computing. Communications bandwidth begins to replace micro-processing power as the key commodity, attention shifts from local area networks (LANs) to wide area networks (WAN), particularly corporate Intranets, and most businesses try to webify their business in order to exploit the economics of network externalities as expressed in Metcalfe's law.

Metcalfe's law, named after the inventor of the Ethernet, states *"the cost of a network expands linearly with increases in network size, but the value of a network increases exponentially"*. In other words, as networks, (e.g. websites, discussion databases, groupware software, distributed databases), expand toward infinity and become ubiquitously accessible and shared, they become dramatically more useful and cost-effective. Software economies follow a similar pattern, because once software is designed, the marginal cost of producing additional copies is very low. Combining network and software economies huge potential economies of scale arise producing significant opportunities for value creation. Metcalfe's law is also being referred to as the "webonomics" as nowadays the web network technologies increasingly become the universal interface and conduit to new and existing digital applications. Or as Papows (1998, p. 390) more critically argued *"the web browser, when and if used effectively, masks the identity of just about all other underlying hardware, rendering the inner workings of the Net effectively"*.

Indeed, Intra/inter-enterprise networking is proliferating by using LAN and WAN. By 1998, the fundamental network-centric applications were e-mail for messaging and the WWW for e-commerce activities promising even lower transaction costs. The development of the Internet based technologies, i.e. Inter/Intra/Extra-nets, revolutionised this era providing great efficiencies in communication and multi-level integration within organisations, with partners and/or with customers. Moreover, the development of object oriented and relational databases enabled interlinking of all information kept by businesses that in turn boosts the generation of synergies and leverages the value of information use. In the hotel context, Sigala et al (2001c) clearly illustrated how ICT integration issues fostered the development of the concept of central rooms management whereby corporate hotel companies can manage rooms and rates inventories and maximise yield throughout multiple distribution channels and hotel locations.

The underlying trend nowadays is the integration and convergence of hardware, software, telecommunications and content/media. Ideally, the Internet related technologies would become ubiquitous, i.e. accessible anytime, anywhere from any device, leading to a stage of pervasive computing and information whereby day-to-day personal life and all business operations would be highly dependent on ICT power. Networking has been perceived as the most important element of contemporary IT revolution (Buhalis, 2000). Indeed, synergies and interoperability between processes, departments and functions enable enterprises to reduce their labour costs, to increase efficiency and to make better informed decisions, eliminate duplication of tasks, enhance transparency of information and decisions within organisations, empower employees to improve performance (Sigala et al, 2001a; Sigala and Connolly, 2002).

5.3.4 Content Era

Mochella (1997) summarised the key characteristics of this era in the following shifts: from electronic commerce to virtual businesses; from wired consumer to individualised services; from communications bandwidth to software, information and services; from on-line channels to customer pull; and from a converged computer/communication/consumer electronics industry value chain to one of embedded systems. A content-centric era of virtual businesses and individualised services would depend on the previous era delivering an inexpensive, ubiquitous, and easy to use bandwidth infrastructure. The economic driver would be 'information economics', combining the infinite scale economies of software with the nearly infinite variety of content. Thus, the fundamental consideration would be the extent to which an industry or business is 'bit-based' (information led) as opposed to 'atom-based' (reliant on physical product). In this vein, Metcalfe's law would be superceded by the law of transformation dictating that the extent of an industry's subsequent transformation would be equal to the square of the percentage of that industry's value-added accounted for by 'bit' as opposed to 'atom' processing activity.

The major technological advancements of this era are summarised as follows. Software applications with embedded artificial intelligence and learning facilities are increasingly being used in order to predict users' behaviour and desires, personalise products and achieve mass customisation. Data mining and data warehousing technologies are being used for knowledge management applications (i.e. applications that allow organisations to gain information about their functions and to build knowledge about approaches to resolve problems and emerging issues), one-to-one marketing or Customer Relationship Management applications, (i.e. the identification, building and maintenance of long-term relationships with profitable customers). Data modelling and knowledge management enhances the usage of operational data in decision making enabling better informed strategic and operational decisions. ICT applications that support Computer Supported Cooperative Work (CSCW) facilitate the development of organisational knowledge and enable employees to share experiences and solve problems.

In this era, benefits arise from exploiting the information generated in the virtual value chain within the marketspace (Rayport and Svioka, 1995). Exploitation of digital assets can have immense economic significance in a network-centric era, but organisations would have to rethink the ways they assess and monitor benefits from IT investments. In the hotel context, Sigala et al (2001c) illustrated how hotels are changing the way of calculating and maximising yield (i.e. the one-to-one YM) in order to maximise individual transactions by collecting and analysing customer information. Sigala (2001a) proposed a framework for the development of effective e-marketing strategies in the hospitality sector that aimed at the exploitation of the three fundamental Internet capabilities namely interactivity (customer information and relationship building, connectivity (network externalities) and convergence (ICT integration). Findings from her benchmark study on e-marketing strategies of hotels in Greece (Sigala, 2001b) provided empirical evidence of this framework. Specifically, highly sophisticated and customer oriented e-marketing strategies outperformed e-marketing strategies that did not fully exploit Internet capabilities and only used the Internet as a publishing and communication vehicle.

Rayport and Svioka (1995) identified five economic implications in this era:
- Digital assets are not used up in their consumption but can be reharvested;
- Virtual value chains redefine economies of scale allowing small firms to achieve low unit costs in markets dominated by big players;
- Businesses can also redefine economies of scope by utilising the same digital assets across different and disparate markets;
- Digital transaction costs are low and continue to decline sharply; and finally
- These factors together with digital assets allow a shift from supply side to demand side, more customer-focused thinking and strategies.

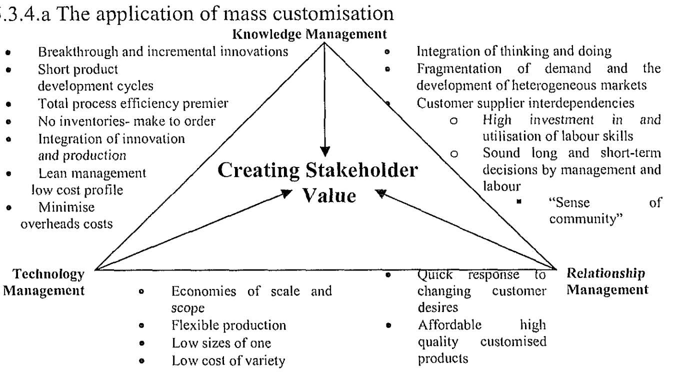
ICT developments in the network and content era have fostered and coupled with shifting demographics and changing customer needs and preferences. In addition, the increase of disposable incomes indicated the need to satisfy a highly individualised segmented market with a wide spectrum of customers' choice and an immediacy in demand satisfaction. As a result, the mass production concept and systems of production for homogeneous markets is not anymore enough to ensure high performance and efficiencies. To that end, ICT are used to support and enable the concept of mass customisations, which was seen as a response to the changing customer circumstances and expectations (Pine, 19993) or as an alternative to McDonaldization (Taylor and Lyon, 1995). Indeed, mass customisation is made available by the application of "new technology" (e.g. computer based design, knowledge mining and warehouses tools) together with new approaches to management (e.g. relationship management, CRM) with the objective to "deliver" affordable products/services with sufficient variety and customisation (Pine, 1993; Gilmore and Pine, 1997). Pine (1997, p.7) argued that businesses that have already adopted such practices have already found out that not only can higher quality yield lower costs, but so can greater variety and they are so now begging to master *"a new frontier in business competition"*.

The economic logic of mass customisation is clearly explained by Pine (1993). Unstable demand leads to market fragmentation whereby product variety becomes an essential feature for customer satisfaction. Consequently, producers undertake specific niches in order to meeting specified and feasible customer requirements, principally through post-production systems. At that stage, production systems were characterised by expensive loss of production time and "set-up", but niche markets accepted premium prices that compensated producers. At later stages though, experience leads to reduced production costs and product variety at the same or even lower costs. Walters (2000, p. 424) expanded the argument further offering an additional explanation to the success of mass customisation. That is the notion of *"coproductivity, whereby suppliers and customers agree to share the production and logistics tasks for some benefit such as price"*. Such customer-supplier "agreements" can be seen in several industries, e.g. in the discount airline operators such as "easyjet", "Go" and "Buzz", Automated Bank Machines, check in/out hotel kiosks etc. Moreover, supplier-staff agreements are also evident, e.g. the widely adoption of "multi-skilling" work practices that allow hotel staff to function across departments and functions in order to provide customised tailor-made personal service (Olsen and

Connolly, 2000). The concept of the "prosumer" (i.e. the participation of the customer in the production) and its role for enhancing staff productivity and customer service had also been earlier advocated in the literature (Tofler, 1970).

Actually, Walters (2000) viewed the economic logic and application of mass customisation as a integrated synergy between three management issues, IT management, relationship management and knowledge management (Figure 5.3.4.a). In other words, the practice of mass customisation requires actions on what information is being collected, disseminated and analysed, indicating the need for co-ordinated management practices in the three management fields.

Figure 5.3.4.a The application of mass customisation



Source: Walters (2000)

Although Pine's (1993) arguments mainly referred to the manufacturing sector, Jones (2001) advocated and clearly illustrated how manufacturing practices have been for long been successfully applied within the hospitality and tourism sectors, e.g. cook-chill. In the same vein, mass customisation practices are also challenging and being adopted within the hospitality industry (Jones, 2001; Connolly and Sigala, 2001).

Overall, the functionalities of one ICT development stage are not replaced by those of another, on the contrary, the functionalities are increasingly enriched and complimented. For example, Werthner and Klein (1999) categorised yield management systems in the first stage, automated workflow back office procedures in the second stage and contextualised product information in the Web and content era, but they argued that all exist in parallel, are interrelated and enhance each other. In this vein, the features and effects of each era become blurred enhancing each other and creating a new competitive arena.

5.3 Frameworks of ICT management practices and their benefits; extending the operations frontiers

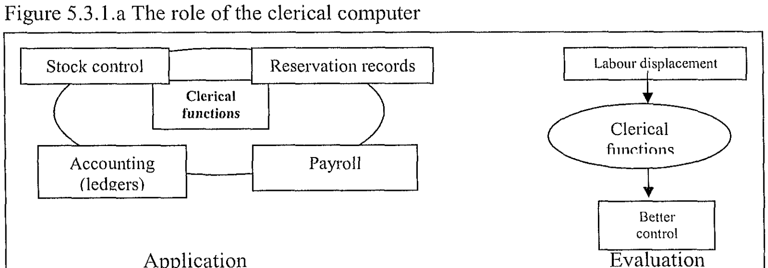
The developmental stages of ICT included in most models describing the process of technological innovation through time (e.g. Nolan, 1973; IBM, 1981; Churchill et al, 1969) are also reflected in frameworks illustrating the developmental stages of management practices fostered and supported by ICT. This is as explained due to the push and pull between ICT and organisational processes and needs.

5.3.1 The development of information management

Early in 1965 Anthony identified three types of IS used in organisations namely operational, tactical and strategic that correspond to the organisational roles of the three managerial levels. Rockart's model (Rockart and Morton, 1983) also proposed three development eras based on the technologies used to support each one. The first era involved administrative and clerical applications using third generation languages like Cobol, while the development of fourth generation tools such as application generators or relational database managers resulted in a second era of ICT applications characterised fully automated functions such as completely automated inventory control for supplies or reservations. A third information era begun when fifth generation languages such as Prolog or tools such as expert systems shells enabled organisations to employ applications such as Decision Support System.

Gamble (1991) advocated that these developmental stages can also be mapped onto hotel operations and illustrated that by developing a scheme consisting of four stages namely the clerical computer, the administrative computer, the tactical computer and the strategic computer. The clerical computer illustrates the first era of computer adoption in hotels, whereby operations in front and back offices such as accounting and reservations are automated in order to be processed at electronic speeds (Figure 5.3.1.a). However, the design and the function of the system into which ICT are incorporated remain substantially unchanged, while the value of ICT is often measured in terms of labour displacement and better control. The use of ICT in order to replace clerks was argued not substantial to improve productivity in hotels, since for a greater investment similar amounts of information are produced. However, hotels major problem is the sheer volume of data and so ICT capabilities (e.g. information storage, analysis should be deployed to solve that.

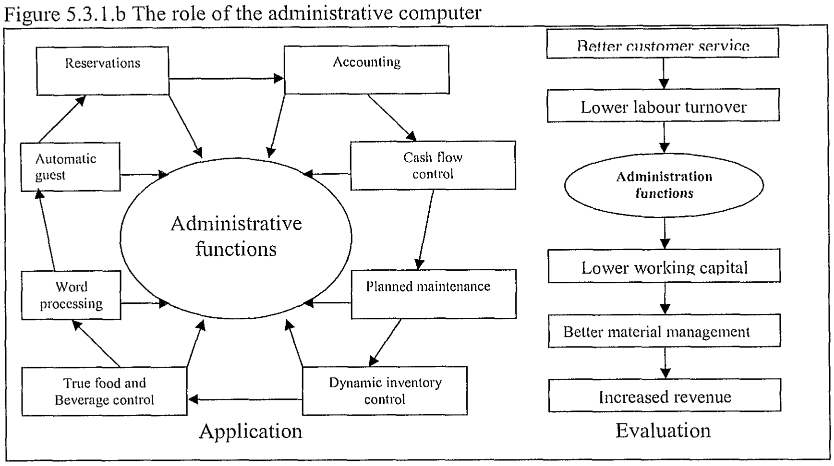
Figure 5.3.1.a The role of the clerical computer



Source: Gamble (1991)

The second stage, referred to as the administrative computer, illustrated a change in management mindsets reflected in the use of computer based procedures that differed from manual procedures totally changing the way in which they operated and leading to substantial productivity gains (Figure 5.3.1.b). For example, time consuming tasks such F&B control are undertaken by cheap and efficient machines, procedures that depend on keeping good records like cash flow management, guest history or personnel administration can be transformed. At this level, computer assessment based on cost displacement is not useful and so, evaluated criteria include better customer service and staff relationships due to the removal of boring and repetitive jobs.

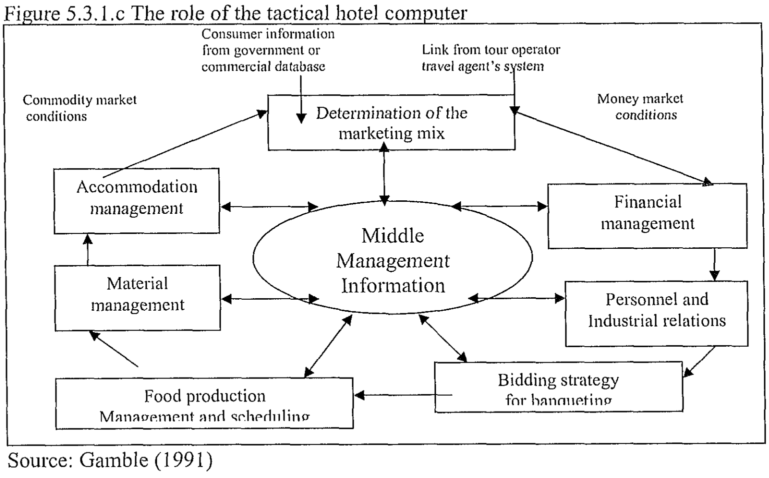
Figure 5.3.1.b The role of the administrative computer



Source: Gamble (1991)

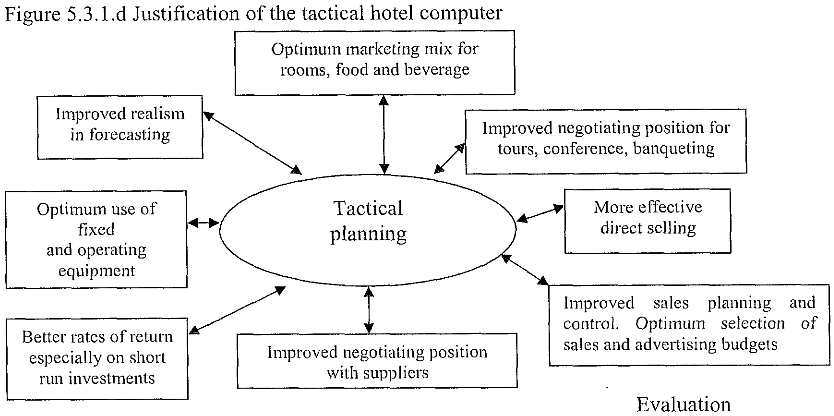
Gamble (1991) coincided Rockart's second era to the tactical computer and the emergence of end user computer (Figure 5.3.1.c). That meant that managers could use the ICT tools to support their tasks, i.e. decision making, directly, which in turn moved ICT beyond the stage of simply facilitating the ordinary business functions of hotels towards the use of external data to influence tactical decisions, e.g. YM systems. At this stage, hotels can gain competitive advantage through the effective use of information and the design and application of their computer based systems along the lines proposed by Porter and Millar (1985). Hence, ICT is being assessed on its value to middle managers for tactical planning (Figure 5.3.1.d).

Figure 5.3.1.c The role of the tactical hotel computer



Source: Gamble (1991)

Figure 5.3.1.d Justification of the tactical hotel computer



Source: Gamble (1991)

In his final stage referred to as the strategic computer, Gamble (1991) tried to speculate how ICT could transform the hotel and indeed, his predictions are not far at all from current reality in hotels. He (1991) specifically envisaged that: 1) all levels of management would be involved in ICT infrastructure on which their decision making would heavily depend; 2) the direction that the hotel would take would be determined by the output of the information system, e.g. the hotel market segments, kind of products/services and the way they would be provided; 3) flexibility would be provided by the application of many automatic functions supported by computers; and 4) there would be a massive extension in the use of external data sources and much more integration between these and the information services of the hotel itself, e.g. automated links between airline CRS and hotel operating systems.

Zuboff (1988) also proposed a three-stage model of ICT management practices, in which she illustrated three concepts namely automate, informate and transformate. This is more closely related to the previously analysed ICT developmental stages.

Automation of simple routine tasks has been referred to as the cornerstone of computing (Groth, 1999), as it is the first and most basic application of computers, e.g. from word-processing to reservations handling etc. Groth (1999) argued that automation can be perceived as the creation of programmed routines and so it is a development that falls with the bounds of the basic coordinated mechanism that Mintzerg (1979) called standardisation of work. This becomes more evident when the programmed routines incorporated into automated systems are compared with explicit routines traditionally used as organisational blue prints before ICT.

In other words, computer automation was regarded as the mechanical automation introduced in manufacturing some decades ago. In this vein, the former was considered as a "canned" action, i.e. as the enactment of previous design that helped to overcome people's limited capacity to carry out physical operations in parallel and required staff to carry out only their ordained tasks. Automation standardises work processes that help anticipate and plan outcomes and usually results in job specialisation, deskilling, greater employee control and decrease in staff levels.

Nevertheless, automation has also been argued to broaden the span of competence by decreasing job specialisation. For example, computerised yield management systems and their integration with reservation systems have allowed sales staff to negotiate and place reservations without having any knowledge of yield management or going through corporate offices. Groth (1999) called this "re-integration" or "despecialisation" and argued that it is possible because it builds on two pillars: easy retrieval of information and embedded ICT knowledge. The important aspect of despecialisation is that reducing the number of steps in the work process, also reduces the need for information transfer, one of the most time-consuming activities in any office and a major source for errors and misunderstanding. Overall, Lucas (1986) summarised the span of automation effects in five impacts namely the impact of automation on the nature of work, the individuals, the interpersonal relations, the interdepartmental relations and the organisational structure (Figure 5.3.1.e).

Figure 5.3.1.e Impact of office automation

Impact on the nature of the work

1. Automated systems, especially word processing can improve the quality of documents
2. automated offices permit increased specialisation of skills to support administration
3. communications aspects of automated offices can alter the physical and temporal boundaries of the work

Impact on individuals

4. automated office systems can affect the identity and stress level of office workers, especially secretaries and clerical workers
5. automated offices can affect the status and satisfaction of office workers
6. changes in the location of work can affect the professional's feeling of identification with organisational goals and the criteria for promotion
7. office automation can lead to improved efficiency of communication
8. office automation can lead to decreased face-to-face contact between managers and a secretary between colleagues and between superiors and subordinates
9. office automation can lead to an increase in the total volume of communication in the organisation
10. office automation can affect the total volume of communication between departments
11. office automation can affect managers' perceptions of the degree of rationality, flexibility and scope of their work
12. office automation can affect methods for monitoring and controlling work
13. office automation systems can increase the span of control of managers

Impact on interpersonal relations

14. office automation can reduce the quantity and quality of social interaction in the office
15. office automation can affect the number of links within the organisation and the volume of communications among the links

Impact on interdepartmental relations

16. office automation can affect the degree of interdepartmental conflict, interdependence, and definition of boundaries

Impact on organisational structure

17. office automation can facilitate changes in the definition of physical organisational boundaries
18. office automation can improve the ability of the organisation to accommodate structural changes

Source: Lucas (1986)

In her book, Zuboff (1988) argued that ICT goes beyond traditional automation and coined the word "informate" to describe this capacity. Informate was explained as an ICT capability referred to as "a fundamental duality", meaning that while the activities of classical machines only result in concrete products, ICT in addition to this *"...simultaneously generates information about the underlying productive and* *administrative processes through which an organisation accomplishes its work. It provides a deeper level of transparency to activities that had been either partially or completely opaque",* (Zuboff, 1988, p. 280). Moreover, as ICT can easily analyse gathered information, their main contribution is a deeper understanding and more sophisticated control of complex processes.

Therefore, as Groth (1999) argued, ICT improves the availability of information in two ways. First, as Zuboff (1988) noted the increasing use of computer-based systems means that a larger and larger part of the information used and processed in an organisation is captured and registered in the organisation's computers. The systems will often capture and retain information that has not been collected earlier at all, because it was too difficult or too expensive (e.g. register every single drink sold in an hotel bar at the point of sale). Secondly, access to this information greatly improved both the storage in integrated databases allowing remote access and machine-to-machine communication. Moreover, computer-based systems can transfer information at greater speed, which means that organisations can have information continuously updated in real time, without any perishable delay between the registration of an information item and its use, two actions that can take place in totally different places.

To Zuboff (1988), automation and informating form an hierarchy, where informating derives from and builds upon automation. The informating aspect of ICT was also regarded as the real revolutionary one, the one that would cause most of the organisational changes in the future by increasing dependence on human competencies (Zuboff, 1988). Specifically, Zuboff (1988) advocated that the capability of informating represented an appealing aspect of ICT, because it seemed to favour increased use of human intelligence, learning, teamwork and a concominant decrease in hierarchy and the application of Tayloristic/scientific management principles. More authors shared Zuboff's arguments i.e. that automate and informate ICT applications may not necessarily imply a decreasing dependence on human skills, but on the contrary, it may entail an increasing dependence on knowledge.

Indeed, the collection of "know what", i.e. collected information, entails enhanced "know how" skills, i.e. staff should have the knowledge of what information to collect and how to exploit it. Hence, nowadays, the concept of informalisation is linked to the notion of the intelligent enterprise (Quinn, 1992), i.e. the nurturing of the employees' capabilities to build, use and share knowledge and to create superior services as well as knowledge management ICT applications, i.e. the identification, collection, storage, dissemination and use of organisational information.

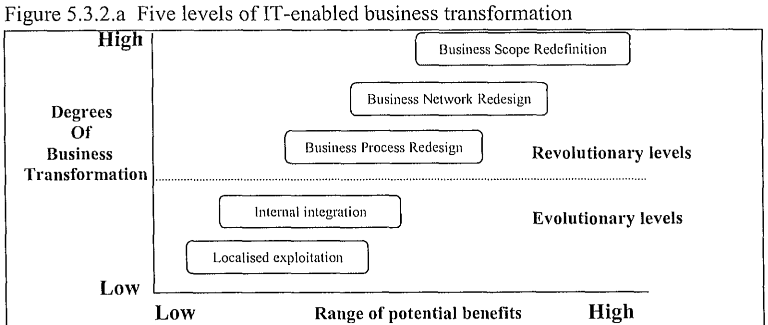
In addition, the requirements for knowledge may well be unevenly distributed in the organisation. Groth (1999) claimed that the statement that automation decreases the dependence on human skills is very narrow as it is based on a "local" interpretation of skill – that is on looking only at the concrete (and presumably lost) skill of the worker who is replaced by machinery of some kind. Groth (1999) also supported that as an increasing number of routine jobs are eliminated, the jobs left will in most instances require a higher skill than those eliminated, which means that the average skill level in the organisation will rise. On the other hand, the skills required in both automation and informated organisation will increasingly be of the intellect kind, and the ability to work through symbols and abstract thought would become much more important.

Finally, recognising these revolutionary ICT capabilities as well as their substantial organisational effects, Zuboff (1988) proposed a third stage, i.e. transformate, of ICT management practice to illustrate any use of ICT aimed to change totally the business model and way businesses traditionally operate.

5.3.2 The development of communications

Although Zuboff (1988) succeeded to conceptualise and map the effects of managing one of the important elements of the ICT concept namely "information", she failed to illustrate changes in management principles that can result from the exploitation of the other, usually ignored, ICT's element namely "communication" mainly introduced during the networking era. The latter is clearly illustrated in Venkatraman's (1991, 1994) model, who considered ICT as a fundamental enabler in creating and maintaining a flexible business network. Venkatraman (1994) specifically argued that the technological interconnectivity between the ICT elements enable five levels of transformation and of processes' integration. He (1994) illustrated this by developing a five level IT-enabled business transformation framework that also distinguished between evolutionary and revolutionary levels of organisational change required in order to derive maximum benefits. The framework is based on two dimensions namely the ICT's potential benefits and the degree of organisational transformation. There is also the assumption that ICT benefits are marginal if only superimposed on existing organisational conditions (e.g. strategies, structures, processes and culture), i.e. the range of potential benefits increases from the first level to the final level.

Figure 5.3.2.a Five levels of IT-enabled business transformation



Source: Venkatraman, 1994

"Localised exploitation" and "internal integration" levels of change are found at the evolutionary level. Localised exploitations was referred to as the leverage of ICT in isolated systems, e.g. inventory control systems, (and so similar to Zuboff's automation) while internal integration involves the leverage of ICT throughout the entire business process. Revolutionary levels of change entail "business process redesign", "business network redesign" and "business scope redefinition" that have the potential of greater benefits but require higher degree of organisational changes. Business Process Redesign aims to optimise business processes from a process-oriented approach, while Business Network Redesign goes beyond the boundaries of the firm aiming at changes along the value chain and benefits for all strategic players. Business Scope Redefinition entails a redefinition of the current, core competencies and functions. Hence, Venkatraman's framework also clearly illustrated how ICT can foster Business Process Reengineering initiatives but the benefits of the latter and how this can be achieved are discussed in more details in the following sections.

5.3.3 The integration of information and communication

In his effort to reconcile the Zuboff's and Venkatraman's view, Groth (1999) used the terms "cell automation" and "hyperautoation". Groth (1999) defined cell automation as the isolated automation of single tasks that has driven investments in computer systems from late 1980s and onwards. He (1999) went on arguing that although the main contribution of cell automation is in eliminating routine work, which may represent no more than a significant reduction in the number of typists, such personal support tools provide mainly what is termed bounded improvements in productivity – i.e. local improvements within the confines of the job holder's usual set of tasks and responsibilities, e.g. higher local (cell) output per employee. Moreover, computer-based increases in personal productivity do not have the ability to lead to substantial organisational changes and performance improvements, because the rational of performance improvement through cell automation was job specialisation in itself and not the IT tools and their capabilities that followed (Groth, 1999). Thus, the potential for organisational change built on specialisation and an increase in individual productivity, which can result in tremendous organisational productivity increases, is largely exhausted already by the first transition of organisations towards functional specialisation. Consequently, there is no reason to support that a further increase in productivity at any isolated step in a process – even if it is substantial – in itself should be enough to lead to substantial productivity gains. Output of the total organisation may increase, but unless the automated cells are linked into some sort of department – or organisation –wide system, traditional coordination methods and organisational structures will most likely prevail and the bounded productivity improvements will not translate into significant changes on the organisational level.

In other words, as concerns organisational improvements fostered by cell automation, Groth (1999) argued that they do not involve any new principles and they mainly represent improvements and extensions of the development process started in the 18^{th} when scientific management principles were introduced. Groth (1999) also argued that functional or cell automation was met with less success in the office than in the factory due to the much higher volume of information that has to be translated from person to person as part of the work process in office environments. Any increase in functional specialisation in the office will therefore normally incur a considerable overhead in the form of information transfer and so efforts to absorb all the relevant information may take longer time than doing actual work. Moreover, numerous information transfers also create ample opportunities for errors, misunderstanding and loss of information. Reducing the number of information transfers and bottlenecks in an organisation will therefore contribute greatly to its productivity.

Groth (1999) also argued that as the basic characteristics of ICT are different, the keys to exploit them are quite dissimilar relative to the tools that induced machine automation and functional specialisation in modern times. So, ICT capabilities can extend the sophistication of automation far beyond what was possible by mechanised means alone and so, rather than marking the end of straightforward automation, the computer inaugurated the age of hyperautomation.

So, in contrast to specialised machinery, the computer is a general, information processing machine that is able to adapt to an extremely wide array of tasks and so its main ability is to support coordination and planning and to carry automation to new levels of complexity and sophistication. ICT can so affect the design and coordination of work processes and the linkages between different tasks and achieve its greatest effects through directing physical processes of far greater complexity with superior efficiency and flexibility and with much less overhead than before (Groth, 1999).

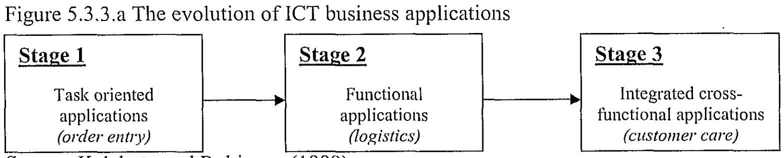
This ICT ability and application was termed "hyperautomation" and is compatible with Venkatraman's model advocating the ICT's capabilities to design a flexible organisational network coordinating processes along the value chain and system. Hyperautomation makes it possible to integrate a much greater span of organisational activities into one coordinated process, not least because it allows the automation or elimination of significant administrative processes. In principle, hyperautomation effects are based on the coordinative effects of a common and unified database with the value of the integrity of the information it delivers.

The organisational effects of ICT applications aimed at the integration of processes or activities along the value chain are also widely mentioned. Galbraith (1992) added the notion of computer based information systems to the integration of people oriented mechanisms and processes as a vertical integrating system. In investigating the role of ICT in the coordination within the organisation, Rockart and Short's (1991) research findings suggested four major classes of impact that can lead to organisational gains:

1. Technology changes many facets of organisational internal structure, which affect roles, power and hierarchy.
2. The emergence of IT team based and problem-focused, often makes work groups as a primary organisational form.
3. Organisations are disintegrating as their boundaries are extended by cost-effective ICT communications between firms, suppliers and customers. The notion presented was that companies are shifting towards more market-based organisational forms, with specialist firms undertaking many of the functions formerly performed within the hierarchical firm.
4. The improved communication capability and data accessibility is leading to systems integration within (and across) businesses, leading to improved communications and integration of business processes across value chain functions and territorial scope.

Kalakota and Robinson (1999) also identified three stages of ICT business applications that clearly illustrate the evolutionary impact of ICT capabilities on integrating and coordinating business processes (Figure 5.3.3.a).

Figure 5.3.3.a The evolution of ICT business applications



Source: Kalakota and Robinson (1999)

Stage one refers to task oriented ICT applications aiming at simplification and segmentation. However, although task specialisation improved productivity dramatically, it also fragmented process beyond recognition. In a task centric world, processes tend to become slow, inflexible, error prone and replete with the costs of the managerial overhead needed to hold them together. Stage two involves ICT functional applications aiming at reintegration and transformation. In the 1980s, the task-oriented nature of applications evolved to become more functionally integrated, as ICT allows the integration of tasks into connected processes. For instance, order entry was transformed into sales applications (e.g. guest history databases integrated with reservations systems). But again, functional specialisation can be crippling. What was really necessary was the provision of ICT solutions that will enable all staff to comprehend the big picture and remain flexible in the face of new or complex situations, which basically led to the third stage of ICT applications.

Stage three refers to integrated cross-functional applications, called application clusters, that aim at cross- functional integration and fluid adaptability and represent the foundation of e-business. Kalakota and Robinson (1999) argued that the boom of the third stage ICT applications coincides with the substantial BPR initiatives started in early 1990s, when businesses began focusing on managing and optimising cross-functional business processes. Indeed, both an ICT pull and push on BPR has been investigated. Clearly, the trend has been towards software process support that can transform a group of ad hoc and fragmented functional activities into a system that is organised, repeatable and reliable. This is accomplished by deploying ICT business applications that fuse multiple functions into a collection of well-orchestrated clusters. For instance, increasingly sales applications are being integrated with customer service and marketing applications to form CRM solutions. Applications clusters are of different types, each of which represents a related cluster of functionality. The implementation of application clusters represents a total overhaul of enterprise systems. These applications clusters are designed to integrate an array of internal functions, including: CRM, ERP, Selling and Chain Management, EAI, knowledge management and Decision Support Systems.

Noble (1995) also clearly described how due to advances in technical integration, office systems are developing from a narrow conception of "office automation" into organisation-wide systems with strategic significance. He particularly illustrated how office systems can be used in order to reduce uncertainty in three major areas i.e. task/production, the environment and the co-ordination, by means of respectively, internal process integration, boundary-spanning systems and organisational infrastructure, which are also significant means of creating new organisational forms.

Specifically, Noble (1995) identified four stages of ICT applications in office: data processing, departmental office systems, isolated applications and integrated office systems. Computers were first applied in the office to the routine handling of numerical data by clerical workers, which is now almost entirely subsumed under data processing or transaction processing. The focus of this stage was on efficiency, productivity and cost savings.

The next major stage of office systems occurred in the late 1970s and 1980s, when hardware suppliers began to offer "office automation" products, bringing together minicomputers, terminals and peripherals with software packages. The introduction in the 1980s of word processing, personal computers and professional/technical workstations meant the beginning of the stage of the "*isolated applications*" (Noble, 1995, p.241) which developed into the departmental "office automation". The underlying conception was that of automating the individual office or department (KMG Thomson McLinton, 1986), by mechanizing isolated activities such as correspondence, text production, message handling, filing and record keeping (Tsichritzis, 1986). Office activities were seen as suitable targets for software development because they are observable, structured, relatively unambiguous and measurable (Hirschheim, 1985), and generic, i.e. very similar across many organisations and thus constituting a large potential market. Thus, a generic facilities-based approach was developed for the administrative office that was neither directed at specific business needs, nor was it concerned with the purpose or function of the office in the organization (Noble, 1995). Moreover, these applications were introduced piecemeal and like generic office automation and so they facilitated work as it was currently being carried out. In this vein, the lack of strategic focus from the data-processing phase thus continued into the stage of office automation.

Consequently, what may be called departmental office automation had a limited success, both in the sense that take-up was slow (Price Waterhouse, 1988) and that where installed it was frequently under-used (Farmer, 1987). Because use was discretionary, failure was unspectacular but represented by unused boxes sitting on desks, in cupboards or storerooms, low levels of exploitation of the facilities available and low levels of financial benefits realised. Numbers of staff did not noticeably dwindle (Noble, 1995). The "paperless office" also turned out to be an illusion (Immel, 1985), because where office automation had been introduced paper was not only still in evidence but had actually increased (Long, 1987). However, "generic" office automation was also argued to be a step towards integrated office systems, because it integrated different facilities into one coherent software package with a consistent interface to the user and consistent procedures across facilities, and provided electronic links between users and previously independent devices.

According to Noble (1995), the current stage, described as integrated office systems, began in the late 1990s. The need for integration in office systems had been recognised throughout the 1980s (Simons, 1984; Wainwright and Francis, 1984; Farmer, 1988), but was prevented by technical barriers such as incompatible hardware and software, lack of common standards and poorly designed systems. Most of these problems are now being addressed by the development of products such as open systems standards while organisations are establishing policies of standardising hardware and software. Noble (1995) argued that technological integration has been occurring at a number of different levels, e.g. integration of data and text with image and voice, the convergence of communications with computers, but he advocated that it is the system integration which has strategic implications. He (1995) identified the integration of existing systems, the linking of departmental systems across functional boundaries, the integration of communications across organisational boundaries. According to Noble (1995) technical integration enables strategic applications of office systems, because it facilitates and supports organisational integration.

Indeed, it has been argued that the future of OA is an expanding domain as the ability to apply OA to a variety of tasks within the office continues, as there is an accelerated rate of change in the development of office technology and systems (Lyytinen, Klein and Hirschheim, 1996; Klein, 1996). It has also been suggested that OA is expanding so that organisations in future will depend on global ICT infrastructures, e.g. groupware systems, intranets that leverage managerial and professional expertise, telecommunications networks that create the virtual enterprises, firms, markets and opportunities (Remenyi, Money and White, 1997).

Such developments in office systems and automation clearly reflect the following definition of office automation systems given by Hirschheim (1997, p. 12): "*the application of integrated computer, communication and office product technologies and social science knowledge to support the activities and functions in an office environment*". Hence, as data in office automation is shared, text intensive, semi-structured, highly interactive and constantly changing, office automation systems process this data in order to facilitate the process of deliberation, debate, decision support and staff co-ordination (Uhlig, Faber and Bair, 1995). To that end, an integrated ICT office automation infrastructure is an important element in establishing an electronic workplace environment (Popel, 1997; Galliers and Baker, 1997; Jones and Hughes, 2000). The former can also empower users to streamline business processes by communicating, sharing and adding value to information, because the focus of ICT is the distributed workforce with its primary focus on the work processes of the business, not on the professional tasks of the individuals (Hirschheim, 1997).

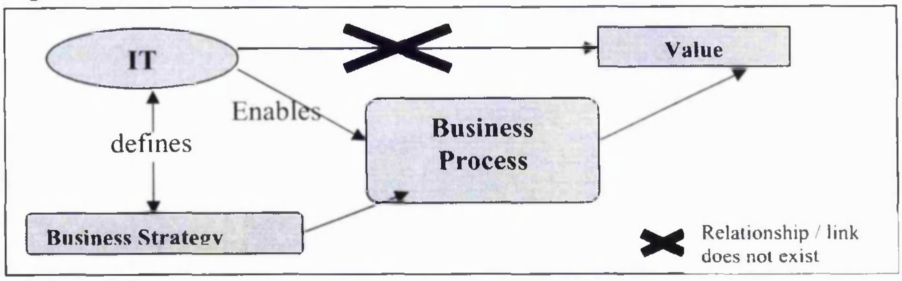
Overall, the value of all these frameworks is twofold. First, they actually illustrate and identify the wide diversity and spectrum of management practices towards the application of ICT. To that end, they identify the crucial issues required for successful implementation of ICT applications and demonstrate the wide spectrum of ICT benefits and organisational gains. In fact, they clearly make obvious that ICT benefits directly depend on how ICT capabilities and tools are being used.

However, the conceptualisation of these frameworks was primarily driven by the need to illustrate the evolutionary development of ICT applications (which is directly reflected in the fact that they consisted of stages) rather than the aim to construct a theoretical framework that would summarise and encompass the different management practices aimed at the full exploitation of all the elements of the ICT infrastructure. Thus, for the purposes of this study a framework is required that would: identify and encompass all management practices aiming at deploying ICT elements and capabilities that will be "time free", i.e. would not imply sequential adoption; clearly show and analyse the link between these management practices and enhanced performance; and have a specific but generic conception at the same time in order to be flexible enough to incorporate the new management practices that rise due to the changing environmental, organisational and ICT developments. In this vein, the following section advocates the usefulness and applicability of a framework of summarising and identifying ICT management practices (i.e. applications) that clearly illustrates and explains how ICT can best and fully exploited to enhance productivity.

5.4 Framework relating ICT management practices and productivity

Werthner and Klein (1999) argued that the effect of IT investments and in particular improvements in productivity is being questioned primarily because of our limited understanding of the organisational impact of IT and of structural changes it causes. Therefore, they (1999) suggested that an investigation of the impact of IT on productivity should entail a detailed analysis on how IT changes, supports and restructures organisational processes, tasks and structures. In the same vein, Wigand (1995) also conceptualised the relationship between value or profit impact and IT as an indirect rather than a direct one in order to highlight the fact that IT boosts value through the improvement of business processes (Figure 5.4.a).

Figure 5.4.a Profit impact of IT



Source: Wigand, (1995)

In fact, there are IT applications that can directly increase value, e.g. new distribution channels can open up a new market increasing sales and/or decrease distribution costs, but Wigand's (1995) major point was to mainly highlight the ignored but significant profit impact of IT via Business Process Reengineering initiatives.

As regards the indirect IT impact on profit, Klein (1996) summarised its dimensions by providing a varied number of attributes (Table 5.4.a). His framework is significant because it partly explains how the deployment of the elements of ICT namely information, communication and network and the exploitation of their capabilities e.g. process restructuring, networking, information sharing can result in indirect IT value.

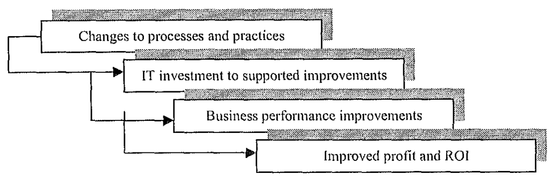
Table 5.4.a Dimensions of IT impact

Dimension	Attributes
Information	Ubiquitous access, shared or pooled usage of information, transparency over distributed processes, selection and filtering of information, changing models of reality
Communication	Improved efficiency and partial substitution of face-to-face communication
Process restructuring	Informatization of processes, process redesign, coordination or integration of processes across functions, products, regions and even companies, impact on roles and power, formalisation, standardisation and harmonisation of exchange relations
Structural changes	Changing governance forms/mechanisms, substitution of human coordination, intensified coordination, creation of coordination intensive structures, decentralisation of information collection and decision making, disintegration, dis- and re-intermediation, centralised data analysis, concentration and cooperation, redesign of value chains, value systems and industries
Network effects	Positive networks externalities, virtual size

Source: Klein (1996)

The indirect IT impact on value is similar to the logic of the concept of the derived or second order value of ICT developed by Soh and Markus (1995), (Figure 5.4.b). According to this, ICT have a derived or second order value, which is realised when they are used as a component of an organisational or business process. In fact for the value of ICT to be generated or realised, it is necessary that the business process or practice to which it contributes actually improve the effectiveness or efficiency of the business. In as far as these processes or practices produce improvements to the business they will positively affect one or more of the performance variables.

Figure 5.4.b The relationship between business processes and IT investments



Source: Remenyi (2000)

In the same vein, Remenyi (2000) paralleled ICT with investment goods and added that classical economics argued that investments goods are not acquired or valued for the utility they deliver by themselves in their own right, but because they are tools which can produce other goods and services that in turn offer utility and value. Hence, he (2000) argued that the way forward to reducing the degree to which IT investment benefits have been elusive requires the recognition that ICT investment needs to be an integral part of a greater programme of process innovation and improvement. Actually that is what Strassmann (1990, p. 93) also pointed by saying *"a computer is worth only what it can fetch at an auction"*. Only when ICT are embedded with the organisational aspects and resources their benefits can materialize.

Davenport (1993) stressed that IT is only useful if it helps people do their work better and differently while Pfeffer (1994) pointed that creating business value through people means working with them, not replacing them, eliminating the scope of their activities or viewing them as a cost to be minimised. For improving productivity, Hope (1994, p. 192) also highlighted that it is the IT use which is directed in leveraging people's capabilities and supporting business strategies rather than IT per se that matters by arguing that:

"The biggest improvements in productivity do not come from machines and technology but from how well managers use technology to improve the organisation and quality of the workforce and whether such improvements meet strategic objectives"

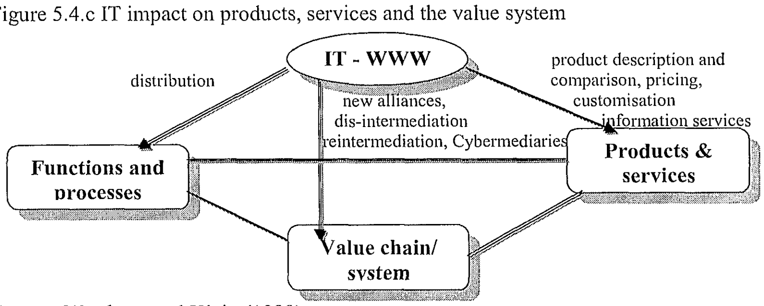
Knox and Maklan (1998, p. 12) also noted that:

"...the value of IT no longer lies in its ability to crunch numbers quickly. IT creates value in the organisation when it helps it to develop a profound understanding of the capabilities of the IT and of all that is required to exploit its potential. In the best companies, IT is often a catalyst for re-inventing costumer value, business process improvement and improving organisation structures"

Taking into consideration current changes and challenges in the tourism environment, Werthner and Klein (1999, p. 155) identified three major areas of how IT can impact on business strategy and operations, which in turn can result in substantial organizational benefits (Figure 5.4.c):

- Adjusting functional strategies and processes whereby the infrastructure of distribution channels is of a high importance;
- (Re-) Designing value chains: network roles and linkages and value chain dynamics;
- Defining the business portfolio (products and services), e.g. pricing, configuration, customisation and comparison should be taken into account.

Figure 5.4.c IT impact on products, services and the value system



Source: Werthner and Klein (1999)

In other words, it is advocated that the impact of IT on productivity is identifiable in its ability to enable and support changes in work processes and value chains as well as to informalise products/services allowing individualised customisation. Organisations making different use of ICT are expected to demonstrate different ICT benefits. This approach also emphasises that organisations must recognise that they are not making IT investments but they are investing in IT-enabled change in the overall business system. To produce results, IT investments should be supported by change initiatives such as BPR, mass customisation and organisational change. Delivering ICT benefits is a business and not technology problem that goes beyond having the right IT and information at the right place to include a clear understanding of the desired business outcomes and of the changes that are required in how an organisation operates in order to achieve these outcomes.

Performance measurement frameworks that distinguish between "results" of action taken and "drivers" or "determinants" of future performance, as discussed in chapter two, also argue the impact of Klein and Werthner's (1999) dimensions on performance. For example, in advocating the application of the balanced scorecard in the hotel industry, Denton and White (2000) illustrated the impact of actions aimed at the improvement of business processes and provision of customer oriented products and services on financial performance.

Overall, the advantages of Klein and Werthner's (1999) framework for identifying ICT management practices enhancing productivity are as follows:

- it identifies the impact and link of all elements of ICT with performance, e.g. information, communications, applications and computing;
- it is ICT system and application free, meaning that it recognises that each ICT application can be exploited differently, e.g. an organisation may exploit the information element of ICT but not its networking.

- it is time free, meaning that it recognises that organisations can implement any ICT without having to go through a strict sequential process;
- it is strategically sound, because it identifies critical ICT applications that can address internal and external environmental situations.
- Klein and Werthner (1999) further elaborated the framework to include operational practices in which tourism and hospitality businesses are engaged in order to implement it;
- the impact on performance as well as the operationalisation of each of its three dimensions is widely argued in the literature.
- it is generic, but specific at the same time, meaning that ICT management practices that may evolve in the future can be easily incorporated within one of its three dimensions.

The specific ICT deployment practices within each dimension as well as their impact on business value as argued by Klein and Werthner (1999) as well as by other authors are provided below. The impact and management practices of the first two dimensions (functions/process and value chain/system) are explained in the section referred to as management practices focusing on business processes while the third dimension (product/services) is analysed in the section referred to as management practices focusing on information.

5.4.1 Management practices focusing on business processes

Investments in ICT can considerably improve business processes in four areas by: improving business processes and efficiency; business process re-engineering; creation of an organisation-wide database; improving management information.

5.4.1.1 Improving business processes and efficiency

The application of ICT for increasing efficiency in business processes has been explained on: "automation" Zuboff (1988); "localised exploitation" Venkatraman (1991, 1994); "cell automation" Groth (1999). Thus, the application of ICT to automate and increase the efficiency of tasks has been widely argued in the literature. In the hospitality industry specifically, Jones (1988) identified three changes in the service delivery system introduced by the introduction and adoption of ICT as a formal approach to productivity improvement. First, the use of computerised point-of-sale hardware enables monitoring of labour productivity, measured as covers per manpower for instance and hence managers are able to arrange staff rotas to reflect more accurate peaks and troughs in customer traffic. Second, many of the administrative and clerical roles became highly efficient, producing more accurate information and a greater throughput of paperwork with considerably fewer staff. Third, the introduction of computer technology into the front-of-house activities has reduced the clerical and often tedious aspects of the work, so that receptionists for example are left free to focus on the more qualitative, service aspects of their role. However, such use of different computer databases and systems for different parts of the business can lead to several problems such as duplication, inconsistency, avoidance of responsibility, lack of control, customer orientation and response to environmental changes.

Where separate databases exist then data need to be transferred from one system to another, which very often is done manually by re-inputting some of the data. However, this can cause several problems: duplication of work and overhead for staff time; log jams in the paperwork chain; detrimental effect on customer service because of delays and referrals to different departments; unnoticed "disappearance" or errors in data, indeed, the more complex the organisation, then the greater the controls necessary to ensure that data are transferred correctly from one system to another.

Inconsistency occurs when each of these departments has a different idea of precisely what customer information is important to them, since this normally determines what data they input. As a result the quality of the information will vary from system to system, e.g. misspellings or incorrect data. Moreover, inconsistency between systems may exist in terms of the coding structure used to set up this information and so, the key fields by which data consolidation can increase or fall.

Unstructured and independent databases also create unclear or even lack of data ownership, which in turn leads to avoidance of responsibility. In fact, no one person owns all the various aspects of data within an organisation and managers usually assume that another manager is responsible. Consequently, lack of control arises when one part of the organisation mistakenly assumes that another department is responsible for a particular process.

The existence of unrelated ICT systems for each business process also reflects an organisational infrastructure that is department oriented rather than customer process centric. However, increased competition and customers expectations require organisations to adapt a more flexible structure aiming at customer service. Customer centric ICT infrastructure would not only mean better customer service, but it would also mean that management gets consolidated customer information that can in turn enhance decision-making.

For achieving efficiency, effectiveness and market response, Wigand (1997, p. 10) argued that there is a need of structural changes aiming at the following capabilities:

- The reintegration of production and service functions into self-contained processes focusing on customer value as well as business value;
- Direct communication in new forms of work organisation amongst all participants of a value-creating process;
- The ability of employees to process market information, to interpret such information correctly and to act in a customer-oriented fashion;
- The capacity of employees to recognise their unit's contribution to the total corporate value creation and market success, and to share their decisions;
- New roles for managers and employees in less hierarchic organisations.

O'Connor (2000) also argued that improvement of business processes and efficiency in a modern hotel requires: speeding up the flow of information around the hotel; removing layers of administration; using networks, e.g. Intra/Extra/Internets, for real time and two way information dissemination; reducing "log jams" in the paperwork chain; relieving existing systems which may be under pressure; reducing duplication of effort and data inconsistencies.

5.4.1.2 Business process re-engineering (BPR)

The disadvantages and disfunctionalities that arise when using ICT to simply automate "canned processes" are severely noted in, Hammer and Champy 's (1993) well-celebrated paper *"Do not automate; obliterate"*, whereby they strongly recognised the need to first rationalise and re-engineering processes and business before any ICT is applied to them.

However, a literature review on BPR reveals a very little consensus regarding the scope and implementation of re-engineering. Some believe that the central focus of re-engineering should be process redesign (Davenport and Short, 1990) while others suggest it should be integration (Boudette, 1991; Carlyle, 1990). Because IT plays an important, if not central role, some writers suggest that IT must be the driving force behind these changes (Senn, 1991). As Carlyle (1990) mentioned the essence of technologies is their inclusiveness and their ability to allow a multitude of things to happen simultaneously rather than serially. McKeen and Smith (1990) claimed that IT is as important as the other three essentials of BPR namely, a new vision, top management leadership and attention to non-technical issues.

The role of ICT in BPR mainly involves the exploitation of the communication and network capabilities of ICT and it is reflected for example in the concepts internal redesign, business process/network redesign (Venkatraman, 19991) or hyperautomation (Groth, 1999). Indeed, because of their communication features and increasing ICT integration, ICT can dissolve many of the traditional boundaries such as geographical limitations, distances, speed and also work time, expand markets as well as enable the market-driven firm and previously unthought of and impossible processes (Wigand et al, p. 98). Actually, there has been an extensive discussion both on the role of ICT to foster and support BPR initiatives as well as on their resulting organisational benefits. ICT is increasingly being recognised as an enabling factor as well as a stimulus of BPR, allowing firms to break long-standing business rules (Brancheau et al, 1996; Hammer and Champy, 1993; Westland, 1992).

Davenport (1993) identified nine ICT capabilities supporting process innovation and re-engineering that can lead to benefits such as cost reduction, time elimination etc:

1. Automational; the ability of IT to eliminate human labour and to produce a more structure process;
2. Informational; similar to Zuboff's (1988) argument that information cannot only be used to eliminate human labour but also to augment it, "informate" it;
3. Sequential; ICT can enable changes in the sequence of processes or transform processes from sequential to parallel in order to achieve process cycle-time reductions.
4. Tracking; a high degree of tracking and monitoring is required in order to execute some process designs effectively, e.g. rates and room inventory management through yield management systems in order to effectively use reservations systems;
5. Analytical; in processes that involve analysis of information and decision making, IT can bring to bear an array of sophisticated analytical resources that permit more data to be incorporated in and analysed during the decision-making process;
6. Geographical; ICT can help to overcome time and geographical barriers;
7. Integrative; ICT can help in reintegrating split work tasks into organisation-wide databases;

8. Intellectual; More and more companies are trying to capture and distribute knowledge more broadly as they start realising the value of their intellectual resources;
9. Disintermediation; Human intermediaries are ineffective in passing information and ICT is used to establish automated exchanges.

In fact, it is suggested that a whole gamut of ICT can be enablers of BPR initiatives and so, Hammer and Champy (1993) argued that reengineering teams should think inductively, that is, consider what IT allows businesses to do. Earl (1996) identified two recurrent IT elements in BPR applications: a) shared databases (or systems) are often essential in integrating functions and ensuring different actors in a process view their world and activities in the same way; and b) networking which not only allows this integration or co-ordination but also enables both collection and dissemination of data through a process. The claim is however that by understanding and harnessing ICT, business processes can be redesigned in hitherto non-feasible ways. Davenport (1992) provided a huge list of IT led BPR opportunities, but Earl (1996) argued that all these can be summarised under three economic contributions that IT generically offers (Table 5.4.1.2.a).

Table 5.4.1.2.a IT opportunities in BPR

Technology	Economic scope	Process opportunities
Computation	Reduce costs of production	Automating data dependent tasks Disintermediating information processes Eliminating activities
Communication	Reduce costs of co-ordination	Collapsing time and space Integrating tasks and processes Distributing and collecting data/information
"infoware" (databases & systems)	Reduce costs of information	Monitoring processes and tasks Analysing information and support decisions Archiving and making sense of experience and expertise Modelling and conceptualising processes

Source: Earl (1996)

Several other authors have argued the relationship between ICT, BPR and their organisational benefits. MacArthur et al (1994) argued that BPR is inextricably linked with IT and that the IT's innovate and ubiquitous nature renders it an obvious mechanism for breaking the mould and for supporting new forms of relationships and ways of working. Teng et al (1994) also claimed that BPR unleashes many of the potential benefits of IT and represents a shift from IT's predominant focus on efficiency enhancements (automation) to that of a fundamental enabler in creating and maintaining flexible business networks (Venkatraman, 1994). To that end, IT was recognized to play several roles in BPR, e.g. as an consolidator, automator of business processes or even an innovator role in business models/products/services.

Powell (1980), Houdeshel and Watson (1987), Yates and Benjamin (1991) and Madnick (1991 and 1995) among others also considered IT as a key driver of BPR. The supportive role of ICT networks for business processes and management tasks is also typified by their definition as proposed by Ein-Dor and Segev (1978, p. 1065): ICT networks comprise the set of equipment and personnel for "*collecting, sorting, retrieving and processing information which is used or desired, by one or more managers, in performance of their duties*".

Bhatt and Stump (2001) also argued that electronic inter-connectivity between two or more organisations has become a vital tool to reduce costs and improve services and initiate a variety of strategic initiatives such as total quality management, just in time, boundary-crossing infrastructure services. Swatman and Swatman (1993) and Swatman et al, 1994) advocated that the potential benefits of electronic exchange of data cannot materialise unless organisations adapt their processes. Empirical evidence also showed that the level of integration of Electronic Data Interchange (EDI) into internal business processes crucially affects the degree of benefits that businesses accrue from EDI projects (Cox and Ghoneim, 1994).

Bhatt (2000) and Bhatt and Stump (2001) provided empirical evidence of a positive causal relationship between ICT networks, BPR initiatives and business performance. They (2001) specifically argued that ICT network connectivity and network flexibility was found to be a required condition for the implementation of two types of BPR initiatives namely customer focus and process improvement initiatives, while higher flexibility and connectivity was related with higher performance measurements. ICT network connectivity reflected the extent to which electronic linkages mediate communications and data access within and between firm units. Network flexibility involved the degree to which compatible standards and protocols existed in order to allow heterogeneous hardware and software to communicate and meet present and future business computing environments. By applying a multiple case study, Broadbent et al (1999) also provided positive empirical evidence that the availability of IT infrastructure actually affects the nature, speed and benefits of BPR implementation. IT infrastructure was measured in terms of the number of IT systems, reach, range, IT systems integration that allowed IT systems to provide cross-functional integration and communication.

Buhalis (1998) also claimed that using ITs as a stand-alone initiative is inappropriate and that IT use has to be coupled with the re-engineering of all business processes as well as with the redesign of organisational structures and control systems. Intra/ inter-enterprise operations as well as customer interactions are subject to reengineering in order to increase efficiency and effectiveness in the underlying processes. In reviewing best practices in hotel operations, Siguaw and Enz (1999) also reported that a key facet to all best practices was the streamlining of processes and a restructuring of how work is being done either within departments or between departments. They (1999, p. 53) emphasised that whenever ICT were also involved, success of the practices was ensured by first designing and restructuring the new processes and then applying ICT in order to support the new initiatives.

Despite the well-accepted iterative relationship between the nature of business processes and the significance of IT investments found in the literature, ICT have also been recognized both as barriers/constraints/inhibitor to and enablers for changing business processes, (e.g. Bashein et al, 1994; Benjamin, 1993; Broadbent and Butler, 1995; Davenport, 1993; Earl, 1994; Earl and Kuan, 1994). Earl (1996, p. 68) used the term *"functional stovepipes"* in order to illustrate the inefficient processes that can be embedded and perhaps preserved by ICT architectures and systems. However, ICT infrastructure investments have been regarded as a constraint on BPR principally because of the legacy of architectures built to serve the past. This might be the case where for example (Earl, 1994): systems are not compatible or where inconsistent data models have been used in different parts of the business; data and system architecture built to serve local, functional needs may put limits on process integration. Hence, arguments regarding the constraining role of ICT on BPR basically reinforce the need for integrated ICT architectures.

Unfortunately, much of the hospitality industry is characterised by legacy systems that were never intended for the flexibility and connectivity required of current systems (Olsen and Connolly, 2000). The legacy systems often use cumbersome programming languages and are unable to support contemporary applications for communication and sharing data (e.g. O' Connor, 2000; IHRA, 1999). Moreover, the industry lacks technology standards that define data requirements and record layouts for passing data among applications. For example, it is very often the case that incoming electronic requests and reservations are re-keyed into internal reservations systems as the seamless integration between systems is both difficult and expensive due to the legacy of existing systems. On the contrary, Werthner and Klein (1999) argued that the integration of electronically transmitted data into internal information systems is the basis for subsequent changes within the receiving organisation.

Several authors have also tried to model the ICT led business transformations. Venkatraman's (1991 and 1994) framework is the most celebrated. This identified five levels of IT-enabled business transformation that distinguish between evolutionary and revolutionary levels of change and advocate that different levels of ICT management and interconnectivity can lead to different levels of process restructuring. It was also recognized that higher degrees of transformation lead to higher organizational benefits. Indeed, Hiuzing et al (1997) research findings provided evidence that there is a strong positive correlation between the breath of reengineering efforts (measured in terms of the number of processes redesigned/restructured e.g. local project, cross-functional project and organisation wide program) with the number and size of reengineering benefits, e.g. reduced process-cycle, reduced costs, increased sales etc.

In the same vein, Werthner and Klein (1999) also proposed a three level organisational change composed by Business Process Redesign (BPR), inter-organisational Process Redesign (ioBPR) and Business Network Redesign (BNR), which highlights the significant role of systems integration (Table 5.4.1.2.b). Technological integration should support organizational integration at all levels in order for the IT benefits to materialize (Swatman and Swatman, 1993; Swatman et al, 1994; Clark and Stoddard, 1996).

Table 5.4.1.2.b Organisational and EDI scope of BPR, ioBPR and BNR

Level of analysis	Organisational scope	IOS scope
BPR	Internal processes	Integration of IOS into internal systems
IoBPR	Inter-organisational processes • e.g. simplification of processes based on bilateral agreements , (re-) allocation of tasks • redesign of bilateral transactions or within a supply chain	Implementation issues, such as selection of data and messages to be exchanged. Interchange agreements regarding message flow and responses.
BNR	Business relationships (governance structures) • industry solutions • new industry structures, e.g. direct sales or new forms of intermediation	Standardisation and implementation issues, IOS as enabler for new organisational models

Source: Werthner and Klein (1999)

It becomes evident that conventionally process improvement initiatives reflect an internal perspective and refer to the extent that work related processes in a business have been thoroughly identified, defined and analysed with the aim of detecting and resolving process-related problems. However, there is a growing consensus among researchers that the main aim of BPR should also be to meet customers' expectations in products/services. According to Davenport (1993, p. 221) "... *product/service development and delivery process are likely candidates for innovation in virtually any company*". This view parallels the customer-oriented approach put forward by marketing approaches.

Harrington (1991) also argued that although at an initial stage process restructuring efforts are directed at minimising waste, reducing variance among interdependent activities and eliminating redundancy, at a later stage organisations are not only attempting to prevent errors from occurring it the first place but they are also striving to reach new standards of quality by benchmarking, adopting best practices and upgrading quality and the capabilities of their processes. Bhatt and Stump (2001), Crosby (1979), Deming (1982) and Harrigton (1991) also distinguished between two types of BPR initiatives: a) business improvement initiatives aiming at eliminating waste, rework, returned goods, cost of warranties and other redundant activities; and b) customer focus aiming at meeting customers' demands effectively and quickly by for example maintaining marketing information systems in order to anticipate customers' needs, solve inter-functional problems, introduce new products, keep track of customer complains and act proactively to correct causes of customer dissatisfaction. Werthner and Klein (1999) also claimed that mass customization strategies require extensive restructuring of business processes and enhanced ICT systems interconnectivity.

Some examples of ICTs applications from the tourism sector that indicate BPR initiatives aiming at customer service are as follows: consumers have more information and enjoy greater choice in product and service configurations; a reduction in bureaucracy and paperwork which frees up time for customer service; customising the product and establishing "one-to-one" marketing by using intelligence collected by intelligent systems (e.g. dietary requirements); providing new services (e.g. in-room entertainment); facilitating information tasks (e.g. in-room check out); personalised services (e.g. telephone operator acknowledges guest by name); better integration of departments and functions of organisations towards better service; and enabling inter-enterprises communication and collaboration.

Overall, it is so evident that the application of IT on business re-engineering goes beyond functional automation. It is being used to create corporate wide applications to improve work processes on a scale paralleling to those realised when manual operations were first automated. Businesses are re-systemising, they are changing their fundamental ways in which work is done- by eliminating processes altogether, by simplifying them dramatically, by integrating them with related processes or by restructuring them. These help organisations to achieve quantum productivity increases by eliminating departments, by reducing staff, by cutting layers of management and by identifying functions as unnecessary (Hammer, 1990; Senn, 1991). However, although cost reduction might be the primary goal of BPR, Davenport and Short (1990) claimed that benefits from BPR go beyond efficiency.

Indeed, there is evidence that BPR initiatives can boost both efficiency and effectiveness. Efficiency gains are reported to be accelerating information flows, avoiding media changes and retyping errors, improving process integration across functional departments or even organisational boundaries. Effectiveness is enhanced since the integration of databases enables new applications e.g. product customisation in order to respond to environmental forces. Moreover, the use of IS networks to access and share relevant information from databases has been an instrumental means to eliminate duplicate activities, prevent errors, reduce cycle times in procurement and product development, improve customer service and heighten customers' expectations of products and services. Bhatt and Stump's (2001) research findings provided evidence that the coordination performed by IS networks enables more views to be shared, employee awareness to be broadened and customer expectations to be tracked and met. Fok et al (20001) also provided empirical evidence of the relationship between TQM and ICT integration. Specifically, findings revealed that successful TQM practices were found in organizations whereby IS systems goals and architecture were aligned with TQM concepts and goals.

Examples of efficiency and effectiveness gains are also reported in the tourism industry. Rosenbluth Travel is an exemplar organisation emphasising the use of IT for process improvement. An analysis of their booking and reservation process enabled them to design a system with workflow functionality that increased internal efficiency, e.g. reduced errors and delays (Clemons et al, 1992). On the other hand, Werthner and Klein (1999) argued that the integration of Computer Reservation Systems and the customer databases, enabled airlines to analyse behaviour and patterns even on an individual basis and so adopt their micro-marketing activities accordingly. Christou and Sigala (2001) also suggested that BPR is a fundamental component of TQM practices and so, BPR initiatives were regarded as a core element of their TQM model for the hospitality industry referred to as HOSTQUAL. The model also advocated the BPR as a mediating factor between TQM and hotel performance, while Sigala and Christou's (2001) findings provided empirical evidence of this positive relationship. Sigala and Christou (2001) also reported that the majority of hotel respondents engaged in TQM practices highlighted the enabling role of their ICT in pursuing TQM practices.

O' Connor (1999) highlighted the dysfunctionalities, over/underbookings that are caused because of lack of integration between reservation systems, while Connolly and Olsen (2000) argued that the development of a single image room and rate inventory enabled through ICT integration is an indispensable requirement in the hotel industry in order to boost its performance. Sigala et al (2001c) illustrated how integration between YM systems, reservations and marking systems can actually boost hotel profits while at the same time pursue customer relationship strategies. Sigala and Connolly (2001) also argued that integration between ICT systems and applications is indispensable in order for hotels to transform from process oriented to customer centric businesses and boost their effectiveness. In identifying best practices, Dube and Renaghan (1999) argued that the design, maintenance and integration of information and distribution systems are critical to the delivery and reinforcement of the hotels strategies and brands. Specifically, Ritz Carlton's ability to deliver personal recognition to its regular guests is argued to depend heavily on its sophisticated information system- an electronic format of traditional guest-history systems, while some of the sense of familiarity and the ease of access many customers attach to the Marriott brands are tied to the synergy of their various systems (e.g. revenue system and distribution system).

In fact, the impact of IT and BPR on hotel productivity is expected to be relatively higher and more significant than in other industries, because of the information intensity of the industry. Information intensity is defined as the degree to which a firm's products or services and its operations are dependent on the information collected and processed as part of internal transformational processes and exchanges along the value-added chain (Glazer, 1991; Porter, 1985; Porter and Miller, 1985). Companies that operate within information intensive industries are argued to gain substantial gains from BPR initiatives for the following reasons. Information intensive environments are typically dynamic and turbulent, thereby requiring greater use of IS to ensure responsiveness and to co-ordinate the disparate tasks that may be scattered globally (Glazier, 1991). Glazier (1991) also argued that the relative level of information intensity that firms face has wide ramifications for BPR initiatives. Information intensive firms are usually pressed to use modular and flexible processes and systems for customising customer demands in products and services. At the same time, they are also required to regulate their processes so that different organisations can easily be coordinated.

However, despite the general understanding of many useful roles of ICT networks in improving business processes, empirical studies examining such types of relationships are relatively scarce and in fact often report contradictory results (Duncan, 1995). This is "*especially true with respect to the expected impact on business productivity*", (Bhatt and Stump, 2001, p. 30). As a result, many hotels still find themselves in the situation of making huge investments in ICT, yet remain unsure of what all the benefits from such investments will be. To that end, the investigation of the ICT impact on hotel productivity is crucially important and necessary.

5.4.1.3 Creation of an organisation-wide integrated information system

The application of integrated ICT infrastructures for automating as well as streamlining and rationalising business processes are two of the ways for improving business operations. However, a third way for improving efficiency and effectiveness is the development of an organisation-wide integrated database (or elsewhere referred to as an organisational portal or an organisation-wide data warehouse) that basically stores vast quantities of transaction data in one central database.

The aim of an organisation wide integrated database is to remove duplicated effort and data inconsistencies that have risen because of the existence of different databases in different business areas. Integrated information systems also aim at the creation of a corporate memory, which in turn can enhance the performance of individuals and groups by delivering intellectual leverage. This is because large volumes of information may be stored on easily accessible and distributed databases, which can act as memory enhancers. However, perhaps the main way in which information systems can create a corporate memory is by recording of experience in the form of rules. Examples of such systems are yield management systems and menu engineering systems, whereby process and operating knowledge has been embedded in the systems and staff do not need to remember and know all rules. For example, reservation staff can take decisions on room prices by using the embedded knowledge of YM systems rather than need to know and do all necessary calculations.

The spread of disparate systems is mainly a result of the piecemeal approach to ICT investments whereby each major business area has purchased or designed a system that suits their specific operating and reporting needs and can cause several inefficiencies. The most obvious problem is of course that of duplicated data entry and storage and information inconsistencies. Thus, an organisation-wide database has the following benefits:

- a single database for all aspects of business;
- a single common point of data entry;
- speeded up input to system;
- reduced duplication of effort;
- the removal of inconsistencies and errors;
- improved quality and speed of decision-making;
- enhanced customer service by quickly addressing customer inquires and anticipating customer needs;
- enable other ICT applications, e.g. personalised websites;
- foster the collection and share of organisational intelligence;
- instil new management practices, e.g. team-working and flexible-working, encourage the development of a multi-skilling workforce

5.4.1.4 Improving management information

As it is very difficult to disentangle information from information technology, it is not surprising that most analyses of the IT revolution only occasionally separate the thing being manipulated (information) from the thing doing the manipulation (IT). Moreover, ICT produce and can be used to analyse and disseminate a vast amount of information in the most efficient and timely way. Unfortunately, this focus on technology rather than information has led to a backlash against information issues in general. On the other hand, information about an organisation's performance has long been recognised as an essential requirement for managing it effectively, while with the growth of competition and rising customer expectations, organisations need more, quality and timely information about their operations.

Therefore, a discussion on the organizational impact of ICT should give an equal weight to IT systems and information usage or as Davenport (1993, p. 72) argued "*both issues are relevant and appropriate for a firm's information practices in relation to process innovation and improvement*". The impact of information on businesses was summarized in Zuboff's (1988) concept "informate", while Davenport (1993) identified a number of supporting roles that information can play in the efforts to make processes more efficient and effective. In particular, information can be used in order to: measure and monitor process improvement, integrate activities within and/or across processes, customise processes for particular customers and facilitate long-term planning and process optimisation. Moreover, information is also the focus and enabling tool for improvements in both operational processes, e.g. transactions, reservations etc, as well as in managerial processes, e.g. executive information systems, decision support systems etc.

Overall, O'Connor identified two major functions of information that summarise its value:

1. to support other operational functions – e.g. the supplying of goods or services to customers and then ensuring that the customer pays you;
2. be summarised and manipulated into meaningful strategic information, to be used by the executive to assess how the business is performing overall.

According to Davenport (1993) in order to manage information better and derive the most value from it, organisations have to implement the following steps: identification of information needs and requirements, information acquisition/collection, information categorisation/storage, information packing/formatting, information dissemination/distribution and information analysis/use. In this vein, O'Connor (2000) identified the following ways that systems integration and a corporate wide database can facilitate and support the management and leverage of information within the hospitality industry.

Systems integration provides:

- Quicker reporting; when more than one software package is installed then you must be able to choose a report writer that will extract information from all the packages. This will reduce training time as well as time taken to write new reports. Improved management information derives from: using report writers to extract information, run reports for business critical information, run overnight batch reports; and improved daily control over entry of transactions.
- Improved quality of information: data held on the database should be able to be interrogated quickly and easily so that information in reports could be more reliable; less time would be spent on validating information in reports and fewer inconsistencies will exist.
- Easier extraction of information.

Data warehouses are argued to give a competitive edge to the business because:

- They provide a stable core of information storage, retrieval, accessibility and dissemination;
- They are able to do more than process routine transactions very quickly;
- They enable users to interrogate the system and access data in any specified way;
- They can also provide the ability to report rapidly on business performance and so market trends and problems are made discernible sooner, which make the company more profitable and efficient.
- Data may be collected and collated for analytical purposes faster; this should enable the business to be more pro-active towards the market place.
- Potential over or under bookings should be seen sooner. This should enable management to react to opportunities and respond to problems quicker.
- An analysis of this information should enable the business to understand its customer base and develop one-to-one direct marketing activities and frequent guest loyalty programs.

Several other soft, intangible benefits are argued to derive from the implementation of an organisations wide data warehouse:

- Improved morale. If the implementation of new IT is presented as a positive action then staff morale tends to improve. The change should be presented as broadening the skills base of staff – in effect making them more marketable so that staff will see opportunities to learn new skills. However, it is essential to ensure that user's expectations are managed, because undelivered promised benefits may lead users to grow cynical and ignore the improvements made by the new systems. Thus, providing the user's expectations are managed, the expenditure should have a beneficial impact.

- Motivated and efficient work force. Improved morale should make end users more motivated to perform their jobs, which in turn should increase productivity if they are provided with better tools to do their jobs.
- Reduced confusion/misunderstandings regarding data ownership/responsibility.
- Flexible staff. The introduction of standard organisation-wide systems enables the development of multi-skilled end users. The end users should be more mobile and adaptable within the organisation. With standard company-wide systems they should need less retraining on basic operating skills if they change departments. So, common systems: enable staff to be re-deployed at times of critical activity; minimal software retraining is needed when people change departments; staff understand and are more amenable to job or function changes; and it is easier to recruit trained staff when using common software.

Since organization wide data warehouses can eliminate inconsistencies, allow different views of operational data to be reflected (e.g. all products purchased by a single customer) and provide appropriate summaries, McKeen and Smith (1996, p. 272) also argued that by being accessible across the organisation corporate information should provide more accurate support for decision-making that in turn should lead to four key benefits:

- better cost management: managers by tracking the profitability of products/customers should have better ability to manage profitable or unprofitable ones differently.
- Improved productivity: managers should be able to identify best practices, improve productivity and streamline processes.
- Improved risk management: better information should enable companies to identify patterns of behaviour and activity that are associated with increased risks to business which in turn will allow them to manage the risk more effectively.
- Better customer management: better organised information should give a better customer profile in order to facilitate focused marketing initiatives.

McKeen and Smith (1996, p. 273) went on to argue that proper use of information can have demonstrable benefits at four levels:

- Information has an operational support role as it extremely helps organisations to take the day-to-day pulse (Mintzberg, 1994);
- Information also supports tactical activities, e.g. for micro-marketing;
- A less supporting use of information is the identification of historical trends;
- Information supports new strategic ideas.

The underlying theme of each of these benefits is that they support human management and decision-making, they do not replace it. Poor managers at all levels will continue to make poor decisions, with or without information. In fact, it is very likely that corporate information will help poor decision makers to become worse because it can imbue the manager with an aura of correctness since he/she is supported by the facts. However, if information is viewed as an additional source of input by the manager who knows what she/he is doing and looking for, corporate information can indeed deliver benefits to the organisation (Strassman, 1998; McKeen and Smith, 1996). The challenge is to identify and develop innovative uses of information that can boost productivity.

Thus, although the benefits of ICT applications by improving the flow, collection and dissemination of information have been discussed, it still remains to analyse management practices aimed at creating organisational value through the use and leverage of the information produced. To that end, the next section aims to explore how information can boost organisational value by fostering and supporting the development of new business processes and practices.

5.4.2 Information

The value of information is widely argued in the literature. For example, Holtham (1996, p. 41) claimed that *"although information is more critical to business success than IT, IT gets most of the attention and the great bulk of the investment in managerial time, financial investment and media attention"*. Burk and Horton (1988, p. 92) also argued that information can deliver the following value to organisations:

- The quality of the information itself (e.g. accuracy, currency, reliability);
- The utility of information holdings (e.g. accessibility, easy of use);
- Impact on organisational productivity (e.g. improved decision making, time saving, improvement in product quality);
- Impact on organisational effectiveness (e.g. finding new markets, improved customer satisfaction, product differentiation);
- Impact on financial position (e.g. cost reduction or saving, improved profits, return on investment).

Werthner and Klein (1999) also argued that the value of information and its potential to drive business value is also evident from the fact that the management of information resources is becoming a management task in itself. Szyperski and Klein (1993) developed the concept of logistics of information while Wigand et al (1997) argued the life cycle of information in order to highlight the various tasks of collecting, verifying, transforming, aggregating, disseminating and archiving or destroying information in order to make sure that the right information is available for the right person(s) at the right place at the right time and at the right appropriate level of aggregation. Davenport (1990) argued that the field of Information Management, defined as *"the effective production, storage, retrieval and dissemination of information in any format and on any medium to support business objectives"* (Touche Ross, 1994, p. 12) has emerged as a new discipline of management science that highlights the new skills and knowledge requirements of managers in the information era. It is also evident in several tourism and hospitality organisations that new managerial positions namely, knowledge, information, content or relationship manager that are mainly involved with the management of corporate information have been created, (Pierre and Cindy, 2000).

It is then generally agreed that this continuation of the imbalance between technology and information issues as well as the ignorance of the business value of information are at the heart of failure to achieve the full benefits from ICT infrastructures. Hence, it clear that the need to explore how the use of information can deliver such business value is important. Specifically, the value of information to boost organization performance is classified into three categories:

- Improving business processes;
- Informalisation of processes;
- knowledge management processes.

5.4.2.1 Improving business processes

ICT gathers and disseminates information along the value chain informalising all the processes. Best (1996, p. 7) specifically argued that "*the essential nature of the value and the role which information plays in business is the role of the information in business processes*", while his research findings revealed that the misunderstanding or the non application of this issue can lead to: massive information overload at all levels; frequently ineffective use of IT, with unrealised benefits and costs overruns; poor decision-making; lack of retention or of corporate learning; loss of profits.

The potential of information to create business value by improving or enhancing business processes is clearly illustrated in the concept of the "value chain" (Porter and Miller, 1985), and specifically the series of interdependent "value activities" in which businesses engage and the "linkages" which connect them. However, while the emphasis is on the use of ICT to achieve competitive advantage by delivering cheaper or more highly differentiated products and services, the concept of the value chain must be broadly conceived to encompass the information that businesses create and use as well as the technologies used for processing information. To that end, Rayport and Svioka (1995) developed the concept of the virtual value chain in order to complement the physical value chain of Porter and Miller. The virtual value chain, which actually mirrors the value chain of the marketplace, illustrates the step-by-step process of creating business value from information in the marketspace. The value-adding steps are virtual in that they are performed through and with information. Overall, Rayport and Svioka (1995) illustrated that creating value in any stage of the virtual value chain involves a sequence of five activities: gathering, organising, selecting, synthesizing and distributing information (i.e. activities of involved with Information Management).

Information management is also argued to crucially contribute to the success of BPR initiatives, because information links human and technological resources and it enters into all business processes. Indeed, Davenport (1993) gave a particularly clear and convincing exposition of the relationship between processes and information. He (1993, p. 71 and 72) claimed that "*... despite the much talk and writing about the Information Age, few organisations have treated information management as a domain worthy of serious improvement efforts ...vast amounts of information enter and leave organisations without anyone's being fully aware of their impact, value or cost.*"

A number of studies (Best, 1996; Davenport, 1993) have recognised the role of information on business processes:

- Information intrinsic to the process is the information, which is itself the raw material and the subject of the process;

- Information extrinsic to the process is not the subject of the process but provides the means whereby the process can be controlled. In this case information is ancillary to the process;
- advantage goes to those businesses that are effective in managing and monitoring information about processes and quality;
- information hold an organisational structure together;
- information about a firm's customers can be managed to allow tailoring of products and services;
- information and information products are more and more often the primary outputs of businesses, but the activities involved are unlikely to have been viewed and managed as processes.

Werthner and Klein (1999, p.253) claimed that in the case of travel and tourism sectors information plays an even greater versatile role, since information *"...can be the product itself or a part of a service, it can accompany operational processes or can be used as an input in decision making processes, it can be used as managing or planning information or as a facilitator for individual and organisational learning"*. In this vein, they (1999) argued that the value and use of information in the tourism and hospitality industry should be approached from different perspectives. In this vein, from a tourism suppliers' perspective, they (1999) claimed that the value of information is found in three areas namely knowledge development and management, decision support and operations and they provided several examples (Table5.4.2.1.a).

Table 5.4.2.1.a Types of information and IT usage in tourism

Knowledge development and management	Decision support	Operations
Developing and maintaining customers' profiles, identifying and defining customers' segments (data mining)	Yield management, database marketing	Internal: process management, coordination of operations External: data exchange with other suppliers, DMOs, travel agents, consumers

Source: Werthner and Klein (1999)

Indeed, due to structural reasons (i.e. the high fragmentation and diversity of operators, Schertler et al, 1995) as well as the characteristics of the tourism and hospitality product (i.e. heterogeneity, intangibility), tourism and hospitality is a business that heavily depends on information. Information has been regarded as the "lifeblood" of tourism (Sheldon, 1997), while with the increasing segmentation and sophistication of consumer needs information, the dissemination, collection and use of information to provide customized products is becoming a crucial core competence in which tourism and hospitality businesses should excel. Moreover, travellers' needs for information are increasing because of the complexity of the tourism product, the demand for information rich journeys and the frictions during the journeys (Fesenmaier and Bonifield, 1996). Thus, Werthner and Klein (1999) claimed that ICT provide value by "informalising" tourism and hospitality services by:

- Making available an increasing amount of information about services that enhances transparency;
- Adding new services that improve convenience and problem solving;
- Enhancing products/services by including complementary services that lead to "edutainment", e.g. electronic guides;
- Utilising more efficiently customer information.

To achieve these, tourism and hospitality suppliers respond "structurally" inducing organisational changes and BPR initiatives that are clearly reflected in the design of their information systems, (Werthner and Klein, 1999). The ability of information to informalise processes is also highlighted in Davenport's (1993) arguments regarding the role of information in business processes, but because of the increasing importance of informalisation in the tourism and hospitality industry, the latter will be more specifically discussed in the next section.

5.4.2.2 Process informalisation

According to Werthner and Klein (1999) the informalisation effects of IT can add value in three ways: information services; customization and configuration; and customer relationships.

The tourism and hospitality products have distinct characteristics that mean that the provision of information is crucially important in order to overcome the limitations that they create (Sheldon, 1997; Poon, 1988). For example, because of their intangibility tourism and hospitality products cannot be seen and experienced before purchase, which means that the provision of quality information regarding them can help customer decision-making. Moreover, tourism and hospitality products cannot be stored, which in turn requires the provision of timely and valid information. Werthner and Klein (1999) identified more ways in which ICT can enhance customer service through information services (Table 5.4.2.2.a).

Table 5.4.2.2.a Informational impact of IT and its value

IT impact	Added value
Complexity of the product description	Richer descriptions of tourism offerings enable travellers to make more informed choices
Transparency of the market	More comprehensive information allows comparison shopping for products and services
Time specificity	Timelier information about weather conditions etc. enable tourists to respond to changing conditions and to use last minute offers
Personalised interactions and customised services	Systematic collection and scrutiny of customer information enables principles to provide personalised interactions and customised services for individual customers and customer segments
Concurrency and acceleration of processes	Efficient operations add to the convenience of customers
Substitution of recurrent procedures that do not create value	Automated check-in and check out add to the convenience of experienced travelers

Source: Werthner and Klein (1999)

ICT applications offer also great potential for innovation in the areas of configuration and customisation. At the same time, the hotel industry is experiencing increased globalisation, competition and rising customer expectations, meaning that hotels' performance and competitiveness is significantly dependent on their ability to satisfy customers efficiently and effectively (e.g. IHRA, 2000; Connolly and Olsen, 2000; Connolly and Sigala, 2001; Buhalis, 1998; Nicholls and Roslow, 1989). For example, IHRA Think Tank participants proposed the concept of tribal traveller to highlight that customers are becoming desensitised to advertisements and brand identity and are willing to change providers at a whim based on their needs of the moment and whoever provides the best perceived value at the time. Pine and Gilmore (1998) also argued that we have entered the "experience economy", whereby if hotels do not create a unique, magical experience and demonstrate a high price-value relationship, they are likely to lose out to those who do.

Configuration or aggregation was defined as the bundling of different product or service components to some kind of integrated offerings (Werthner and Klein, 1999). Configuration usually requires a strategy whereby products/services of several suppliers are combined in the production side and a total-customer-care approach is adopted in the marketing/distribution side. Poon (1988) used the concept of "diagonal integration" in order to highlight the trend of tourism and hospitality operators to form alliances in order to provide a whole bundle of tourism services/products, e.g. airlines affiliate with hotel chains in order to provide special travel packages.

Technological applications have fostered the formation of such strategic co-operations, e.g. the GDS or Destination Management Systems (DMS) are becoming one stop shops by integrating varied tourism suppliers (e.g. hotels, airlines, car rentals, attractions etc). Technological innovations have also extended the number of manageable configuration options by decoupling the three components namely content (the core information/product), context and infrastructure (the distribution of the core product) that were considered to determine products/services. Rayport and Sviokle (1994) described how the printed media, e.g. newspapers, are innovatively using ICT in order to offer new flexible bundles of services that consider individualised customer needs (e.g. personalized alerts via email of news that are of interest to the reader, different packages of information, i.e. only financial information or sports and weather, several packages options of the core product, i.e. through email, the WWW or hard copies). In the same vein, Werthner and Klein (1999) also explained how ICT can be used in order to reconfigure the offering in the hotel industry by giving illustrative examples (Table 5.4.2.2.b).

Table 5.4.2.2.b Content – Context- Infrastructure

	Hotel room as a part of a packaged holiday	**Innovative accommodation bundles**
Content	The hotel room with a variety of features	The hotel room with a variety of features, a few features, e.g. Internet access etc, might be added upon request of the customer
Context	The local environment of additional offerings (pool, restaurants, shopping facilities etc)	Inclusion in regional and national tourism malls, links to related sites, combined offerings as part of destination management activities
Product and distribution infrastructure	Tour operator catalogue lists a limited number of configurations (flight, hotel, rental car etc)	Detailed description of hotel, presentation of rooms and facilities illustrates the available choices Electronic reservation and booking facilities increase the autonomy of the tourist, they enable a communication between supplier and tourist in an early stage with extended options of considering the tourists preferences Access to internal on-line database

Source: Werthner and Klein (1999)

Product configuration entails total-customer-care, but also requires customers to get involved in the selection and bundling of components playing an active role in the service production (prosumer). From a marketing perspective this is called reverse marketing, i.e. involving the customer in the process of product and service specification. Shapiro et al (1987) argued that the major advantage of such a strategy is that it allows greater flexibility and transparency, which can be the basis for value added pricing. For example, a pay-per-use pricing scheme may allow customers to pay for whatever configuration of offering they use, e.g. different room prices available through different distribution channels.

Customisation was defined as the process of individualising a product or service (Werthner and Klein, 1999) and it was regarded as compatible with Pine's (1993) concept of mass customization that described the trend towards individualized offerings. Conventional wisdom regarded one-size-fits-all travel packages as cheap solutions in contrast to expensive custom-designed offerings. However, ICT use and improved organisational procedures are reducing coordination costs and are driving customisation costs down.

Several examples exists on how ICT foster mass customisation. Table 5.4.2.2.c provides some pioneers of mass customisation in the hotel industry that confirmed that high tech can be used for and does not exclude high touch. Moreover, some "tinkering" of mass customisation in selected areas in the lodging industry has also occurred in recent years. Table 5.4.2.2.d provides some examples. Sigala et al (2001c) analysed the concept one-to-one yield management in order to illustrate how the integration and sophistication of ICT have enabled the application of mass customisation in the concept and practice of yield management.

Table 5.4.2.2.c Pioneers of mass customisation

Company	Example
Ritz-Carlton	Ritz-Carlton uses software to personalise guest's experience by linking to database filled with quirks and preferences of half a million guests. Any bellhop or desk clerk can find out whether a guest is allergic to feathers, their favourite newspaper, or whether they like extra towels. The company stores guest information in a database and uses it to tailor the service to each guest on his/her next visit. This is a way to transparently customise for those customers who do not want to be bothered with direct collaboration.
Regent, Hong Kong	In the fine dining restaurant, the hotel cosmetically customizes paper napkins and matchbox by printing their customers' name on them. Although personalizing a service in this way is cosmetic, it is of value to many customers.

Source: Mok et al, (2000)

Table 5.4.2.2.d Some examples of mass customisation in hotels

Area	Example
Rooms	Auto-Wake
Front Office	Flexible Self check-in, self check folio review, self check out
In- room Entertainment	Video (PPV, On-demand), Video games/Casino Games, Internet Connectivity
In-room vending	Honor bar, Micro-Based dispensing
Guest information systems	In-room information links

Source: The hotel room of the future; putting mass customisation concepts into practice, adopted from Mok et al, (2000)

However, despite the increasing competitive pressures towards customisation the hotel industry has been reported to be reluctant to use customer information for customisation purposes (e.g. Connolly, 2000; Olsen and Connolly, 2000; Dev and Olsen; 2000). McIntosh and Goeltiner (1995) actually argued that despite the extensive use in technology in order to enhance performance and effectiveness (e.g. computer reservation systems, air control technology, accounting systems), the hotel industry has been reluctant to use ICT in the actual delivery of its services. Indeed, the great reluctance to replace human service providers with technologically driven alternatives has been attributed to the perceived conflict between high touch and high tech.

In the future, it is also envisaged that it would be possible to sell guest rooms that customers could personally customise, down to their favourite wall art, prior to check-in. The Conrad N. Hilton College at the University of Houston, sponsors a project called "The hotel room of the future", whose objective is to develop ideas to assist hotelier's globally to mass customise the hotel product to better meet individual customers' need by mastering technological change. This project is based on the idea that the hotel guest room should be divided into zones, e.g. work, entertainment and relaxation/rest, whereby technology can then be introduced to enhance guest's satisfaction. Technologies that impact upon ergonomics, temperature, light, sound, exercise and diet that can consider physiological, psychological and sociological needs of guests should be considered. Mok et al (2000) described how technologies such as virtual reality, alarm clocks, and fiber technology designed furniture and blankets can be used for such purposes.

Mass customisation has also been viewed as a way of building customer relationships (Buttle, 1996; Pine, Peppers & Rogers, 1995; Quinn & Pacquette, 1990), because through customisation, the needs of customers are better satisfied and switching costs are introduced. To that end, many organisations are reengineering their internal organisation around customer-focused processes, marketing strategies shift from customer acquisition to customer retention, product strategies are built around customisation (Hammer & Champy, 1993; Hammer, 1996; Vantrappen, 1992) in order to deliver value to their customers by delivering customised services and implementing relationship management. These reengineering efforts include both internal (back office with front office operations integration) and external operations integration (e.g. links between distribution channels) for whose implementation ICT play a crucial role (e.g. Kalakota and Whinston, 1996; Venkatraman, 1994).

The relationship of relationship management implementation and performance has been widely argued in the literature. The main rationale is to gain knowledge about processes and so, better process control in order to specialise in customer contact and in the specification of services in the front office as well as to protect the back office from disturbances in production (Gronroos, 1990). Moreover, by building customer relationships businesses can substantially increase their profits, as they can get a better insight into the market needs, plan and forecast their capacity management, avoid high customer acquisition costs and build barriers of entry for other competitors (Heskett, Sasser and Hart, 1990). In this vein, Gummesson (1998) argued that relationship marketing directly influences the "triples", i.e. productivity, profitability and quality by providing the following examples:

- The rationale for relationship management is usually presented to increase customer loyalty and customer retention. Focus has shifted from investing the

major marketing resources into attracting new customers, to caring for existing customers and providing them with the incentives for repurchase.
- In caring for existing customers, the interest in customer share – in contrast to market share – is growing. It means that you want existing customers to fill more of their needs of a product or service from you, thus exploiting the customer base for more sales.
- Increased customer retention and duration of a relationship will lower marketing costs and consequently enhance marketing productivity. Maintaining existing customers is usually less costly than attracting new ones.
- The relationship must be win-win if it is going to be a long-term and constructive relationship; all parties involved co-produce value and must derive individual value out of the relationship. No happy marriage is based on a win-lose relationship.
- In a relationship, it is not just one party that takes initiatives, it is an interaction on equal and respectful terms. Suppliers, customers and all others involved in a network of relationships have a responsibility to be active parties.
- Increased customer retention and duration, as well as the building of more stable relationships with other parties, increase security and help to establish trust and commitment over a long period of time. This facilitates marketing and makes the outcome more predictable.
- Long-term service customers become better co-producers, which facilitates production and delivery. Quality defects go down and it becomes easier to clear up misunderstandings and complaints.
- Service providers can gradually build up knowledge about their customers and target their offerings to individual customer needs.

Indeed, previous research provides evidence of the positive relationship between market effectiveness and hotel performance (Phillips, 1996; Philips and Mouthino, 1998; Appiah-Adu et al, 1999; Norburn et al, 1988; Taylor, 1996). Very recently, Gray et al (2000) conducted an exploratory research on the Australian hotel industry illustrating the relationship between market orientation and business performance (measured as profitability, sales and market share) and indicating the need for hospitality managers to develop better customer relationships and better ways of tracking most profitable customers and products. In her model of effective e-marketing strategies, Sigala (2001a) advocated that sophisticated e-marketing strategies aiming at product and service configuration and customisation as well as customer relationships should lead to higher performance. Indeed, by benchmarking Internet strategies, her findings (2001b) provided evidence that hotels using the Internet for providing customised offers and customer service outperformed hotels (in terms of occupancy, profit, number and ARR of Internet bookings) using the Internet as an advertising and communication medium only.

The role of ICT in implementing these concepts is vital. ICT give service providers the opportunity to gather and analyse customer information in order to gain better insight into their relationships with customers, enable customer focused BPR initiatives, form the glue which holds together the front and back office and provide opportunities for service distribution. For example, developments in e-commerce provide service companies with powerful tools to analyse the behaviour of their customers and build relationships from a distance (e.g. Hagel and Armstrong, 1997; Rayport and Svioka, 1995; Sigala, 2001a), while an increasing number of author recognise the collection of customer information, its sharing within the organisation and the reaction to customers needs as crucial elements of an organisations market orientation (e.g. Gray et al, 1998; Narver and Slater, 1990; Jaworski and Kohli, 1993; Deng and Dart, 1994).

Overall, it is widely recognised that the implementation of mass customisation and relationship management entails: the need to gather, analyse and use customer information; the crucial role of integrated ICT systems in gathering, analysing information, in providing various alternative processes, e.g. ATM, self service kiosks, websites etc, and in enhancing organisational flexibility; and the need to satisfy customers and so enhance customer loyalty and relationships. For example, de Vries (1998) developed a framework arguing that there is a strong relationship between marketing strategies, the degree of customisation of services/products, the information requirements of any customer touch point (e.g. website, front office, call centre etc) and the main objectives of ICT applications, which overall ultimately relate to the effectiveness of the business. Moreover, she argued that higher degrees of customisation and so, greater collection and use of information are explicit and true indicators of relationship building marketing strategies, while lower degrees of customisation and information usages correspond to transaction based marketing strategies Thus, Walters' (2000) view that regarded mass customisation as an integrated synergy of three management concepts i.e. knowledge management, ICT management and relationship management is not surprising.

Actually, Palmer et al's (2000) research confirmed de Vries's (1998) argument regarding the positive relationship between collection of information and mass customisation strategies. Palmer et al (2000) proposed a framework that modelled hotels based on their collection and use of information for product customisation purposes. By testing their model with a sample of medium and larger UK hotel companies, Palmer et al (2000) illustrated that there is a link between information intensiveness of an hotel and the extent to which it is able to customise its service offer. It was also found that availability of structured information procedures did not guarantee that gathered information is being used. Indeed, Wnag (1997) advocated that it is increasingly being observed that many organisations' ability to analyse and use information has fallen behind their ability to collect data (Wang, 1997). However, the limitation of Palmer et al's (2000) research lies on their small sample (12 medium and large companies). Further research should also take into consideration the collection and use of information by multiple ICT systems, meaning that integration and linkages between ICT becomes a crucial issue that also needs to be considered.

5.4.2.3 Knowledge management

Knowledge management is the third area of the productivity impact of the information element of ICT. Arguments regarding the role of ICT to foster knowledge management practices and boost productivity are analysed as follows. Zuboff (1988) established the concept of informatization in contrast to the dominating policy of IT based automation. However, her (1988) concept does not only emphasise the value of information and its potential contribution to improve productivity, but it also highlights the potential to motivate, empower and enhance human resources for innovation potential. Werthner and Klein (1999) also claimed that informalisation has been linked to the concepts of the learning, intelligent or knowledge organisations, which aim to nurture employees' capabilities to build, use and share knowledge to create superior services. Steward (1999) argued that the concept of knowledge management and intellectual capital extends the vision of informalisation beyond the internal value of employees' capabilities and organisational structure (referred to as the human and structural capital respectively) to the external value of customers' and suppliers' information (i.e. the customer capital).

In this vein, Gummesson (1997 and 1998) strongly advocated that there is a strong relationship between intellectual capital (referring to structural, human and market capital) and the "triples" namely productivity, profitability and quality. Indeed, a number of authors have suggested superior market capital with virtuous circles or profit chains, all following a similar pattern: collaboration and motivation between employees → good internal service quality → satisfied employees → employees stay → good external service quality → satisfied customers → customers stay → high profitability (Gronroos, 1990; Normann, 1991; Schlesinger and Hallowell, 1994; Schlesinger and Heskett, 1991). Moreover, the organizational benefits of knowledge management have been widely argued in the literature (e.g. Davenport and Prusak, 1997); Senge, 1994; Hope and Hope, 1997). Drucker (1997) also argued that knowledge management may provide the key to enhanced productivity for fewer and older workers.

It has also been argued that in the information economy the management of intellectual assets is more important and crucial for value creation than the management of physical assets. So, Papows (1998, p. 110) argued that intellectual capital has become "*the central currency business valuation while the industrial economies of product and scale that have long driven business competition are being supplanted by the knowledge-based economies of service and expertise*". Quinn (1992a and 1992b) also reported that successful companies develop value propositions for their customers by focusing on the leverage of intellectual skills internally and on the management of network relationships externally.

The role of ICT infrastructure to lead and foster knowledge management practices is well advocated in the literature. Indeed, Papows (1998, p. 109) claimed that "*experience has shown that true knowledge management is about people and culture as it is about technology*", while Steward (1999, p. 21) argued that "*technology without people won't work, but people without technology won't scale*". Bharadwaj (2000) associated knowledge management with the enabling of organizational synergies referring to the sharing of resources and capabilities across organisational divisions, because beyond operational efficiencies, knowledge and information sharing across functional units enables firms to be more flexible and to respond faster to market needs. In this vein, he (2000) argued that ICT has a great enabling capacity for making other organisational resources more easily accessible and shareable, while Brown and Duguit (1991) argued that ICT geared towards creating organisational synergies can aid in the delivery of needed resources by removing the physical, spatial, and temporal limitations to communication, e.g. an Intranet system linking and enabling co-operation between staff located all over the world.

In the same vein, Papows (1998) considered knowledge management as the next step from groupware ICT applications and its document-centric and messaging-reliant applications to the sort of same-time real-time asynchronous collaborative communication and value creations. Papows (1998) provided the following reasons for his argument. The networks' evolution was accompanied by team members who learned to leverage each other's once private expertise through online discussion groups. These informal, casual exchanges of information ultimately enabled everyone involved in decision making and mutual discovering through corporate intranets. The latter eventually evolved into digital repositories for an organisation's collective intelligence: broad databases accessible to the enterprise as a whole.

By illustrating how ICT such as data marts, data mining, artificial intelligent systems have enabled innovative practices for storing, analyzing and dissemination of knowledge, Kalakota and Robinson (1999) also argued that knowledge management is a series of important breakthroughs in various new ICT that are found in three basic areas namely, creation, discovery/search and distribution.

Brown and Duguid (1991) advocated that ICT systems and applications, such as groupware, data mining and warehouses, are critical to the practice of knowledge management because they speed up communications, elicit tacit knowledge and construct histories of insights and catalogue them. Sabherwal and King (1991) argued that the extent to which a firm's knowledge is embedded in its database and decision support systems determined its ability to respond to environmental changes. Sigala and Connolly (2002) also claimed that embedding knowledge in ICT systems enables its rapid transfer to novices and other new members while cultivating continuous learning processes. Moreover, ICT systems enable knowledge formalisation and consolidation of previous gains as well as their leverage across the organisation, e.g. staff can benefit from learning how other staff have previously dealt with a guest problem in order to provide better guest solutions. Considering these ICT benefits coupled with the high labour turnover, low staff morale and commitment in the hospitality, Sigala and Connolly (2002) argued that knowledge management applications are the "next big thing" in the hospitality industry promising huge gains in operational efficiency and effectiveness.

On the other hand, one could argue that the leverage and sharing of expertise, experience, insight and even intuition have always been critical aspects of business success. However, as Papows (1998, p. 111-112) argued what is different today is not that knowledge is more important than it used to be, but that "*the scope, form, scale and pace of knowledge development has changed so that ICT enabled knowledge management systems are in some way the only way for large at least organisations to cope with today's knowledge requirements*". In this vein, he (1998) went to analyse seven reasons for which the role of ICT is vital for knowledge management:

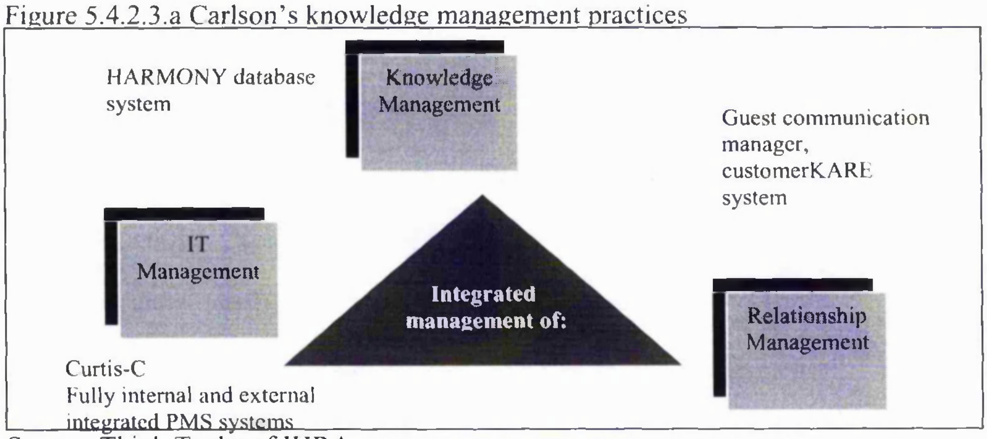
1. globalisation; ICT need to be applied in order to leverage shared experiences and resources and operate in multiple parts regardless of time, volume and distance;
2. speed; ICT can accelerate and shorten processes and market cycles;
3. service orientation; ICT enabling information access, on-job training etc;
4. work dispersion; ICT applications making workers more mobile and geographically dispersed;
5. closer business relationships; ICT that enable closer working relationships with customers, suppliers, partners etc;
6. technology; ICT technologies converge themselves;

7. competition; ICT applications that remain static can be copied and matched easily by competitors and so improvement is often the key to sustained market advantage.

In the same vein, Hope and Hope (1997) argued that people have and will always use their knowledge to create value, but the difference in the information era is that instead of knowledge being vested in one or two clever people it becomes embedded in systems and databases and made available to everyone. Thus, in order to achieve maximum effectiveness, knowledge must be systematically accumulated, shared and purposefully deployed in building the core competencies of the firm (Hope and Hope, 1997). This means for example, that front line workers should be provided with instant access to customer information so that their needs can be satisfied and problems solved immediately and so, systems integration is vital. It may also mean improving business processes through understanding not just the results of management actions but how and why those results came about, i.e. applying knowledge to how work is done.

Carlson Corporation is a hospitality organisation that has been particularly progressive in the area of knowledge management. Like most major companies, it has been amassing large volumes of data in company data warehouses. It then analyses that data using data mining tools to establish patterns and recognise themes and relationships so it can identify new opportunities to target potential customers and refer existing customers to its sister companies. Figure 5.4.2.3.a explains Carlson's ICT infrastructure and the knowledge practices that it enables.

Figure 5.4.2.3.a Carlson's knowledge management practices



Source: Think Tanks of IHRA

5.5 Justification of the framework of ICT management practices boosting productivity

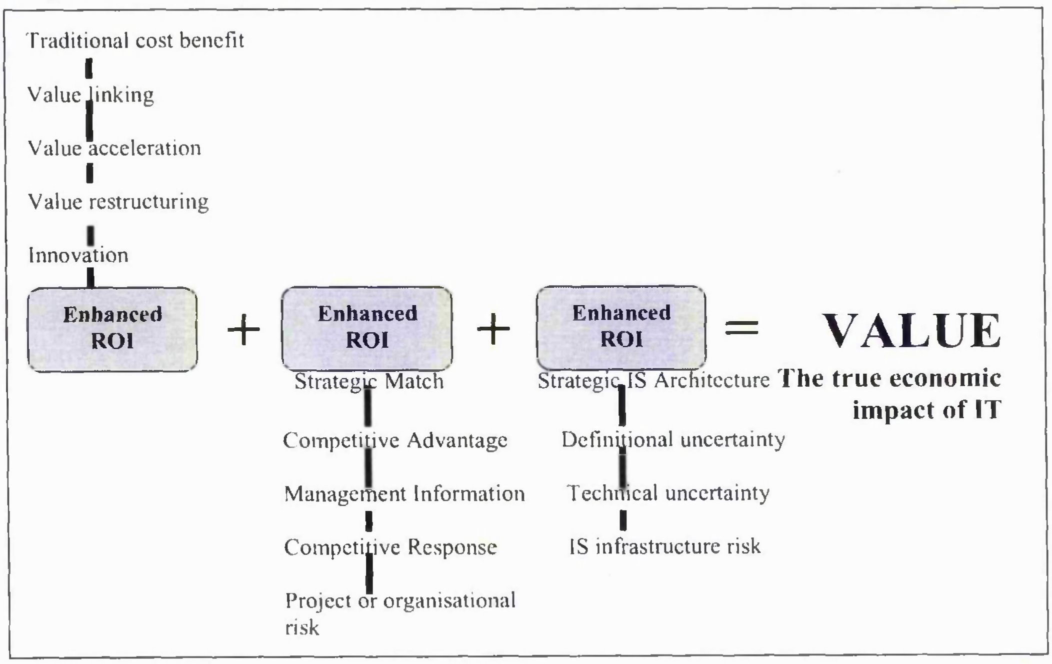
An integrated framework of ICT management practices aiming at exploiting the full potential of ICT to enhance productivity has been analysed and explained. However, the following section summarises numerous arguments also advocating that in order fully to exploit ICT investments and boost organisational performance there is a need to harness not only ICT operational efficiencies, but also their integrating, re-engineering, networking, informalisation and knowledge enable capabilities as previously explained.

So, Venkatraman (1998) argued that firms that will succeed in the 21st century will focus more on knowledge work than administrative work. High performers will also be characterised by organisational structures and processes that leverage the collective expertise of the individuals within an enterprise (Nonaka and Takeuchi, 1995). Effective users of IT functionality will be transformed to process based organisations that increasingly rely on cross boundaries' teams (functions, divisions etc).

The recognition of connectivity/systems integration and the value of information use has been widely recognised in the literature. Evans and Wurster (1999) argued that competition and success in the era of virtual commerce would be based upon three dimensions namely, reach, affiliation and richness. Reach is about access and information meaning simply how many customers a business can access or how many products it can offer. Richness is the depth and detail of the information that the business gives the customer or collects about the customer, while affiliation builds on the richness dimension by using the information to develop customer relationships and "sticky" business practices.

The information economics approach proposed by Parker, Benson and Trainor (1988) as a way to evaluate ICT investments also highlights the areas and management practices that are required in order to deliver value through ICT applications. Specifically, the information economics looks beyond benefit defined as the "discrete economic efficiency effect" to value, defined as the effect of IT on business performance, and so, identifies three different ways that IT adds value to businesses (Figure 5.5.a).

Figure 5.5.a The information economics approach



Source: Parker et al (1988)

First, IT has an enhanced ROI (return on investment) value, as gains come from:

- Value linking: IT investments that create additional benefits to other departments through ripple, knock-on effects;
- Value acceleration: benefits in the form of reduced time-scales for operations;
- Value restructuring: benefits of restructuring a department, jobs or personnel usage as a result of introducing IT;
- Innovation valuation: the value of gaining and sustaining a competitive advantage, taking into account costs or risk of being a pioneer and of project failing.

In other words, enhanced ROI reflects business value derived from ICT management practices that aim at enhancing business processes through, efficiency, streamlining, informalisation etc. Information economics also recognise the additional ICT business value that arise from the business and technology domain. In particular, it is argued that the value of IT is realised or not when:

- There is a strategic match, i.e. the degree to which proposed projects correspond to established goals;
- The degree to which a proposed project can provide a competitive advantage;
- IT projects contribute to the management need for information on core activities;
- IT projects are required as a competitive response, i.e. there is a risk of not undertaking the project;
- There is a strategic integrated ICT architecture that fits into the overall information needs and requirements.

Tapscott and Caston (1993) also identified three critical changes that organisations should undertake in order to take benefit of the new ICT capabilities namely, retooling, re-engineering and realignment. Businesses should retool and provide an infrastructure that allows a continual improvement of knowledge and service worker productivity by exploiting what ICT capabilities and tools are available and necessary for their operations. Hence, ICT capabilities should be exploited in order to foster re-engineering initiatives that may be required at different levels of the organisation from work group and business processes, to enterprise, to relationships with external organisations. Organisations must be prepared to drastically change and streamline operations to change the cost base, if appropriate, and improve effectiveness. Businesses should reassess what and why is being done and develop new ways of producing, servicing and distributing products and services if necessary. Along with other authors, Tapscott and Caston (1993) also highlighted the need to realign these changes with business strategy and assure integration of business and ICT objectives.

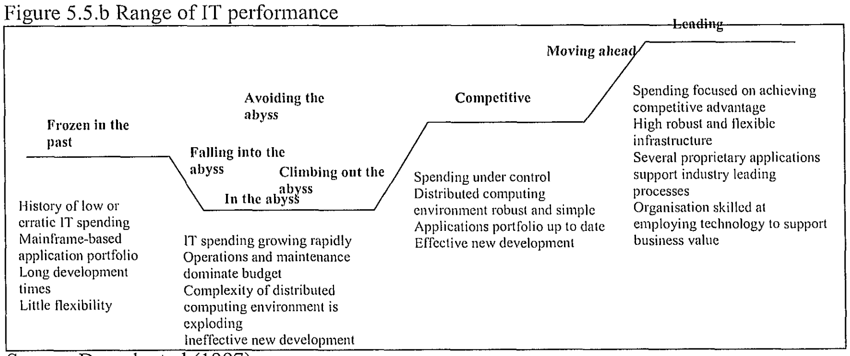
In surveying and identifying best practices from large sophisticated IT users in the service sector, Quinn and Baily (1994) reported that any organisation seeking to improve IT performance had followed the following guidelines:

- Develop a genuine IT strategy. A well defined IT strategy should include and demonstrate a clearly established set of goals, policies, priorities, action sequences and support structures leading to a defined competitive pre-eminence. ICT should be viewed as and used as a tool that both supports and enables firm strategic plans.
- Re-engineer first. Careful process analyses and re-engineering of processes before committing to major IT investments were keys to improving benefits from IT, as many important contributions to productivity and effectiveness came from such re-engineering, rather than from the electronic automation used.

- Involve users and customers. Re-engineered processes usually require restructured organisations and new control/reward systems to refocus work practices. One observed outcome of effective IT systems was the breakdown of these functional structures and the substitution of cross-functional processes, decision making and performance measures. When such practices are initiated dramatic, immediate improvements in costs, response times, quality service are reported. Moreover, restructuring of tasks may result in the elimination of functional units and organisational layers. Interfunctional applications are claimed to be the highest quick payoff of IT applications.
- Develop customer-driven quality metrics. Because financial measures poorly reflect output quality, the elaboration of formal non-financial measures of service quality is important.
- ICT integration. ICT implementation may be better when large scale projects are broken down into smaller, each of which can be justified individually and integrated incrementally into an agreed upon system architecture. However, goals of broad system integration and interface standards should be at the outset.
- Support of new structures with customer-centric as well as knowledge assets performance measures and reward systems. These are required if firms want to monitor and provide incentives for the more efficient and effective use of their ICT and digital assets.

A McKinsey study (in Dvorak et al, 1997) investigating businesses' ability to materialise ICT benefits identified a range of performances: at one extreme are companies that are "frozen in the past" with old, inflexible infrastructure and applications, while at the other extreme are companies that lead the field and gain competitive advantage from their investments. Figure 5.5.b illustrates the characteristics of the variety of performers. The major conclusion of the study was that achieving IT success is about overcoming technical challenges in order to master IT management and deployment.

Figure 5.5.b Range of IT performance



Source: Dvorak et al (1997)

Kempis and Ringbeck's (1998) seven rules for managing superior IT performance also highlight the importance and impact of good ICT exploitation (e.g. for reengineering and restructuring of business processes, the embodiment of information into knowledge product/services, for developing customer focused operations) as well as systems integration on business performance (Figure 5.5.c).

Figure 5.5.c Seven rules for managing superior IT performance

1.	Make IT a priority in product development.
2.	Integrate IT into marketing, sales and service.
3.	Use IT selectively to integrate order processing across the company.
4.	Shift the focus of IT in administration to business planning and management development.
5.	Make IT a top management affair.
6.	Create a customer-oriented IS service network, e.g. systems integration and shared databases.
7.	Introduce integrated standard software on a fast-follower basis – but redesign the business first.

Studies from various countries (Table 5.5.a) have identified the following key important, problematic and critical issues regarding IT management:

- Technology management issues:
    - Building of an integrated IT infrastructure to support a range of applications;
    - Measurement of IT productivity and performance;
    - Improving data integrity, i.e. over inconsistencies between different data sources;
    - Integrating multi-vendor systems;
    - Integrating data processing, office automation and telecommunications;
    - Planning and managing communications, the lifeblood or digital nervous system of the 1990s organisation;
    - Implementing and supporting collaborative support systems;
- Strategic management issues, ICT should not be viewed as a support resource only but an enabler and support factor of business strategies:
    - Improve IT planning by aligning IT plans with business strategic plans within the changing environment context;
    - Develop an information architecture (to identify major business categories and relationships of business processes, guide application development and facilitate data integration and sharing);
    - Align IT with the organisational structure;
    - Facilitate and manage BPR;
    - Use ICT for competitive advantage.
- People management issues, not only IT people but all organisations' members need to develop appropriate knowledge and understand the use of ICT:
    - Develop ICT resources;
    - Facilitate organisational learning, in order to make effective use of ICT across the entire organisation;
    - Educate senior management in relation to IT, in order to support resource allocation and understanding of the strategic impact of IT;
    - Increase understanding of the role of ICT by all members.
- Systems development and data management issues:
    - Integrate package application software;
    - Make effective use of data resources through appropriate database technologies and valuing data as a corporate asset;
    - Manage legacy applications;

Table 5.5.a A history of key IT issues

Authors	Year of study	Country	Sample (Response rate)	Research method
Parker and Idundun	1987	UK	IS managers (45/100)	Survey and interviews
Davenport and Buday	1988	Europe	IS executives (75/ 2,000)	Survey
Watson	1988	Australia	IS Managers (48/200)	Three round Delphi survey
Moynihan	1990	Ireland	CEO/IT Mgrs (49/250)	Structured interviews
Doukidis et al	1992	Greece	IS managers (40)	Personal interviews
Pervan	1992	Australia	IS Executives (88/300)	Three-round Delphi Survey
Galliers et al	1992	UK	Managers (98/500)	Survey
Pervan	1996	Australia	IS executives (105/490)	Survey

Research and arguments from the hospitality and tourism context identified similar trends for excelling at ICT deployment. Industry and academic participants of a Think Tank organised by the IH&RA (Dev and Olsen, 2000) identified the major IT and marketing challenges that hotel and tourism operators will have to face in the new economy as well as the actions that they will be required to take in order to address them. By using the acronym "market", which actually reflects the need to follow a more market/customer oriented strategy, Dev and Olsen (2000, p. 43) reported the following trends of strategic importance and their operationalised actions as identified by Think Tank participants:

- Manage distribution costs; the management of distribution costs has become a major concern among hospitality firms and participants identified three reasons for that: 1) the rising cost of distribution; 2) pressures to increase net income; 3) opportunity to reduce distribution costs from as much as $30 per room to less than $1. Required actions towards this issue are:
    - Continuous evaluation of distribution channels effectiveness;
    - Centralisation and consolidation of distribution function; use ICT networks to centralise reservation functions to one department, which will simultaneously promote all hotel functions, e.g. rooms, conference facilities, banqueting etc.;
    - Understand whether customers require direct access to hotel inventory and provide them with last room availability information;
    - Simplify the distribution process, take control of the large number of channels and rates available. To that end, hotels should work towards systems' integration in order to provide a single image room and rate inventory that can be better and easier controlled.
- Analyse customers; participants all agreed that while hoteliers capture considerable customer data, those data are rarely assembled to create useful knowledge about the customers. To that end, hotels were suggested that they:
    - Analyse data to make proactive marketing decisions and to customise the hotel experience;
    - Establish a continuous dialogue with customers, before, during and after the stay by applying multiple methods and do not solely rely on comment cards. This actually means that in order to create an ultimate customer-

centric hotel, hotels should train every customer-contact employee how to become a researcher, a sales person, and a problem solver. The development of an hotel wide information database can crucially contribute towards that end.

- Rethink the business model; participants all agreed that symptoms such as declining satisfaction scores, diminishing brand loyalty, increasing commoditisation of the product, increasing supplier control, underperforming technology investments and high labour turnover, indicate that the current business model is broken. What hotels should do is to:
    - Identify the value drivers, i.e. what services/products have true customer value;
    - Focus on lifetime value of customers by creating and maintaining customer relationships;
    - Invest in lifelong-learning programs and treat their labour force as knowledge workers.
- Keep control of technology; participants claimed that many managers feel that technology is getting away from them and indeed none of the senior-level participants professed to having a handle on IT's capabilities, how it works, how it benefits, the firm and exactly what value it adds to the customer. Immediate training of hotel staff as well as more communication and co-operation between the IT department and rest of the staff was considered as an urgent act. Equally important action was considered to be identification of the knowledge needs and the use and transformation of data to create knowledge. The key thing is to create technology-based marketing applications that are decision support systems rather than simply data generators. The most crucial example would be to integrate YM and guest history databases to create new personalised offers.
- Evaluate internet-based opportunities; participants worried that hospitality operators were throwing big money at the internet without really understanding what works and what does not work; acts that need to be taken were reported such as track surfing and consumption patterns on the WWW, understand the impact and opportunities of new players, e.g. expedia.com etc
- Track the next big think; participants agreed that the industry has failed to foresee the potential of the new media.

Technological developments place knowledge and information at the core of the competitive profile of tomorrow's hospitality enterprise (Connolly and Sigala, 2001; Sigala and Connolly, 2002; Sigala, 2001a). In the information age, successful hotels will build competitive advantage based on how much they know about their customers, how they will provide them with information about their products/services and how they will profitable distribute their products/services (Connolly, 1999; IHRA, 2000). Gains are also dependent on how much hotels know about their competitors, suppliers and regulators, meaning that intellectual rather than physical and capital assets can develop value added strategies. Connolly and Olsen (2000, p. 30) argued that *"the effect of IT applications is that, more than ever, knowledge is power. In this case, the market power will lie in satisfying guests' knowledge-based needs"*. Olsen (1999) regarded the knowledge based society as one of the four major forces shaping the hospitality industry and Connolly (2000) argued that hotels will set themselves apart based upon their knowledge of the marketplace and their customer database.

Davis and Meyer (1998) also argued that in the challenge of the era of the integrated systems and sophisticated data mining techniques (e.g. intelligent agents, CRM etc) all transactions across the value chain will become in their words *"blurred"*. They defined blur as the product of three concept enables by ICT, i.e. Speed, Connectivity and Intangibles, which imply that: every aspect of the business will operate 7X24X365 hours a day; everything will be connected to everything else (e.g. people, products, companies, nations etc); and every offer made to customers will be a bundle of tangible and intangible elements. Indeed, the intangible element, (meaning mainly the customisation of product elements, e.g. price, service upgrades etc, to the particular customer) is constantly growing and becoming the primary value component of the transaction.

In fact, ICT changes how hospitality services and amenities are delivered, the hospitality organisational's structure as well as the interaction of the customer service provider. Connolly and Olsen (2000) actually framed the challenges that are inherent in these technological changes and that hotels will have to faces under three headings: 1) the pernickety traveller, 2) the hospitality firm as a provider of experiences and 3) employees as value-creating stakeholders.

Indeed, customers are becoming less and less brand loyal, as instead of faithfully sticking with a tried-and-true brand, the consumer will patronize the company that offers the best value proposition for the needs of a particular experience. Firms nowadays operationalise this as competing to create and manage the best loyalty programmes. However, beyond that threshold, the way to maintain customers' loyalty or as elsewhere referred to as to "own" the customer (Moon et al, 2000) will be to add real and significant value to the guest's experience and to that end sophisticated use of data mining, data warehouses and other technology tools will be required. Moreover, by allowing pernickety customers to create a custom experience that suits their individual needs (develop and deliver the hotel service as a concept of a whole experience) hotels could also countervail the commoditisation of their product happening in the electronic distribution chain (Olsen, 1999). To that end, it is highly required that hotels perceive, develop and empower all employees to become value-creating stakeholders who, by mainly forming intelligence response teams and a broad base of knowledge, will be able to respond any customers' complex request.

This scenario stands in contrast to the linear and departmental organisational structure that predominates in the hospitality industry, which emphasises the need for organisational restructuring and reorganisation. To that, hospitality operators should increasingly use ICT in order to foster re-engineering and transformation processes that have the customer at the centre. Moreover, hotel staff will be required to posses or develop more advanced social skills, e.g. role theory, understand conflict resolution, communications and personality identification, (Connolly and Olsen, 2000), while future hotel managers will be required to posses and develop leadership skills in terms of using and managing knowledge and technology for competitive advantage and in terms of developing value added strategies, (Olsen, 1999).

Werthner and Klein (1999) argued that IT applications crossing company departments and borders would support or automate processes that would be critical to companies' future success. They (1999) so argued that the increasing impact of IT on organisational performance would be reflected on the following critical tasks:

- Product creation, that will take care the complex nature of tourism products and individualised consumer needs;
- Adding new or enhancing products/services by informalising them;
- More complex but easier and seamless market access by means of multiple distribution channels;
- Permanents innovation and differentiation that may lead to new pricing strategies;
- Building and maintaining long-term customer relationships, enabled by identification of individual needs and integration of consumers on production.

However, for the realisation of these tasks, interoperability and semantic integration between systems, to enable cooperation and dissemination of information, as well as integrated layered architectures would be the major technical issues that players should manage (Werthner and Klein, 1999).

Connolly and Olsen (2000) highlighted the need for hotels to excel at ICT deployment. They (2000) so predicted that there is going to be a polarisation in the hospitality industry between those who know how to use IT and those that do not know. Thus, merely having state of the art IT is not sufficient, instead, hotels should know how to use those tools and technologies and how to exploit their capabilities in such a way that competitors cannot easily duplicate.

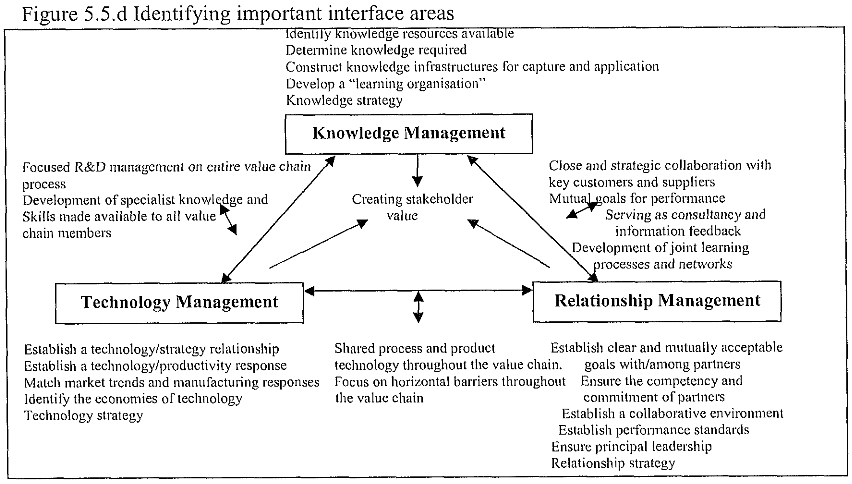
In its report identifying the key megatrends influencing the global hospitality industry in the new economy of the 21st century, Arthur Andersen (AA, 2000) indicated that customer ownership would be the key to securing and maintaining competitive advantage. Indeed, as Kyriakidis (AA, 2000, p.1) argued:

"globalisation is rapidly eliminating boundaries and borders; the rapid proliferation of technology is redefining the meaning of time and space as we know it. The result is the customer is empowered like never before. If the industry does not stay ahead of the curve and remain close to its customers, it faces the prospect of disintermediation as their service becomes increasingly commoditised through the proliferation of electronic commerce"

Relationship management has been suggested as a key to securing a stable customer base, but this is only possible through understanding of customer needs and preferences. To this end, Arthur Andersen (AA, 2000) recognised the importance of Customer Relationship Management (CRM) and Knowledge Management as key strategic areas that hotels should invest. CRM highlights the need to increase customer ownership and implies activities such as: identify most valuable customers, optimise promotions/advertising effectiveness via one-to-one communication, ensure retention of valuable customers through targeted campaigns and gain share-of-wallet by better understanding their customer, avoid the give away of unnecessarily markdowns. Consistent with the drive to secure a greater share of the customer, the industry knowledge management practices seek ways to harness relevant knowledge from guests, suppliers, employees and competitors. Considering these, distribution systems, knowledge, technology, branding are considered to have a profound influence on-day-to-day operations and long-term strategic direction in the hotel industry in the coming decades. However on the contrary, it was recognized that for the majority of hotels, Enterprise Resource Planning (ERP) platforms currently in place are out of date, not integrated into customer data and guest satisfaction databases and so unable to support such practices (AA, 2000).

Think Tank findings are compatible with Walters' (2000) arguments regarding the major drivers of success in the technology heavy "information age". In particular, he argued (2000, p. 427) that *"it would be more sensible to consider "e-commerce" as a facilitator – or a means by which we can add flexibility, reduce operating times, increase accuracy, relevance and control - rather than be the "e-nd" in itself".* Thus, Walters (2000) argued that organisations should understand, manage and co-ordinate the implications of three perspectives namely, technology management, knowledge management and relationship management. The management of these three perspectives is required in order to move from the paradigm of management of mass production that has dominated the world industrial production since World War II to the mass customisation paradigm (Walters, 2000). Figure 5.5.d illustrates the management implications of each perspective as well as of their interrelationships.

Figure 5.5.d Identifying important interface areas



Source: Walters (2000), p. 425 and 428

5.6 A framework for modelling ICT applications and productivity gains

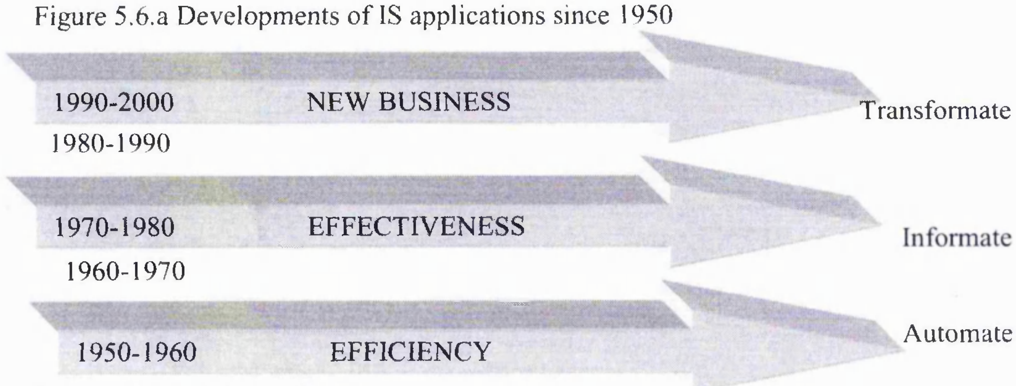
In the previous section a framework of ICT management practices aiming at the full exploitation of ICT resources was proposed and justified. This framework illustrated and summarised the relationship between management practices, ICT and productivity gains by identifying the critical issues of ICT whose exploitation can lead to enhanced productivity. The latter were used in order to develop a model that would reflect how different deployment of ICT applications can lead to different benefits. To that end, frameworks proposed to measure ICT benefits and business value are reviewed and criticised. Finally, a framework appropriate for this study is introduced and justified.

Actually, models classifying ICT benefits have followed a similar approach to frameworks illustrating the evolution of ICT management practices (analysed in section 5.3). This is not surprising when considering that ICT do not have any value in themselves but rather they enable benefit opportunities, meaning that businesses have to exploit them in order to gain any value. Indeed, Ward et al (1996, p. 215) defined ICT benefits as "*the effect of the changes, i.e. the difference between the current and proposed way that work is done*". Earl (1992) also provided support that benefits are associated with business change and not the technology itself. He (1980, p. 12) particularly argued that "*...investment in IT alone usually yields very little return. If substantial business benefits was to be earned, other changes were also required*". The corollary of such views and definition of benefit is a proposition suggesting that firms that have changed the way they do things as a result of ICT are expected to receive more benefits and value from their ICT applications than firms where ICT have not fostered any such change. It is also evident that research investigating the relationship between ICT and performance should not focus on ICT per se but rather on the ways by which they are being used.

In this vein, the relationship between ICT use and performance is clearly illustrated in the following models of ICT benefits.

Recognising that attitudes towards the IT benefits have evolved along with technological developments that enhanced IT capabilities and deployment, Remenyi et al (1991) proposed the following stages of business changes and ICT benefits that coincide with Zuboff' (1988) concepts of automate, informate and transformate (Figure 5.6.a).

Figure 5.6.a Developments of IS applications since 1950



Source: Remenyi et al (1991)

During the automate phase the emphasis was strongly placed on reducing the labour required for manual aspects of clerical work. The main perceived result of this initiative was the reduction of routine and tedious work with the primary benefit being greater speed of paper handling and greater accuracy resulting in better customer service and possibly in some cases reduced costs. These systems are generally referred to as transaction processing systems aiming at efficiency gains. During the second phase, computers were used to deliver extensive management reports, which were intended to facilitate the more effective management and control of the firm. Management Information Systems (MIS), Decision Support Systems (DSS) and Executive Support Systems (ESS) were introduced and these along with their regular reports have been referred to as the organisation's efforts to informate. Achievable benefits may be attributed to savings obtained through applications such as better stock control and production management, improved sales forecasting and better credit management etc.

Since 1970 there has been a great use of IT in order radically to change the way organisations work or even their scope. Strategic use of IT is crucial for the creation of new business and value. Farbey (1993, p. 7) identified the following new benefits because of the new role of IT:

- Competitive advantage, e.g. increasing bargaining power in the competitive arena, creating barriers to entry, tying in customers;
- Co-operative advantage, strategic alliances based on IT;
- Diversification, widening business scope, offering new products;
- Marketing, improving customer service, adding value to products;
- Effective management, improving delivery information, getting new products to market faster, providing a just-in-time service.

By considering the different use of ICT, Van Reeken (1997) also identified six types of ICT applications based on the types of organisational benefits that they can accrue;

1. automation: computers can be used to automate the administration process. This type concern work, repetitive and boring, that used to be done "by hand". This used to be known as the substituting labour by capital, resulting in more capital-intensive production, and production efficiencies.
2. informalisation: as ICT become more sophisticated computers are not only used to automate existing work but also to improve work by providing faster and more information to support decision-making. Shared databases can be used to combine and improve internal processes and enhance organisational effectiveness.
3. alignment: ICT applications of this type aim to support or enable the execution of a business strategy (e.g. Venkatraman, 1991).
4. transformation: in contrast to alignment that leads to re-organising work process without redesigning them transformation ICT applications integrate rather than divide tasks aiming at removing non-value adding internal or external activities.
5. anticipation: ICT of this type aim to proactively improve organisational flexibility through investments in IT infrastructure.
6. venturing: the aim of these applications is to provide new product/market combinations, e.g. offer a new product or offer products to a new market etc.

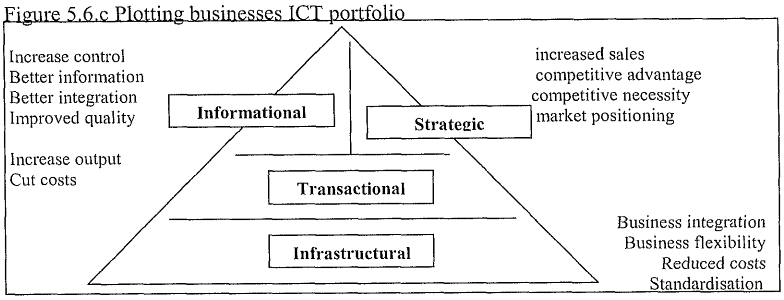
McFarlan's strategic matrix also reflects an effort to develop a taxonomy of IT applications based on the types of benefits that they derive. Four types of IT projects, are identified relating to the types of strategic investments proposed by the Boston Consulting Group (Figure 5.6.b). All types exist in a firm at the same time, but each one requires a different management approach and delivers different benefits.

Figure 5.6.b McFarlan's strategic matrix

Degree to which IT developments will create competitive advantage	high	Strategic	Turnaround
	low	Factory	Support
Degree to which the firm is functionally dependent on IT		high	low

A similar framework (Figure 5.6.c) aiming at clustering organisations regarding their ICT portfolio, i.e. the number of ICT applications, was also proposed. This framework is again based on the well-sustained concept that different use of ICT leads to different benefits, however along with other frameworks it fails to recognise that each individual ICT can be used in all four different identified ways and so lead to a multiple of benefits.

Figure 5.6.c Plotting businesses ICT portfolio



Source: Farbey (1993)

The following matrix has also been proposed for relating ICT use to benefits (Table 5.6.a). This represents IT benefits, (efficiency, effectiveness and transformation) accruing at different level of impacts (individual, function, organisation). Developments in IT applications are categorised in three eras, implying that organisations have to pass through a sequential development of IT. Era I reflects IT applications in certain functions resulting in efficiency and later in effectiveness. Era II reflect benefits of the applications of IT, mainly microcomputers, to the individual. Era III reflects benefits that accrue from strategic applications of IT that transform organisations and empower employees.

Table 5.6.a The matrix of benefits and their impact

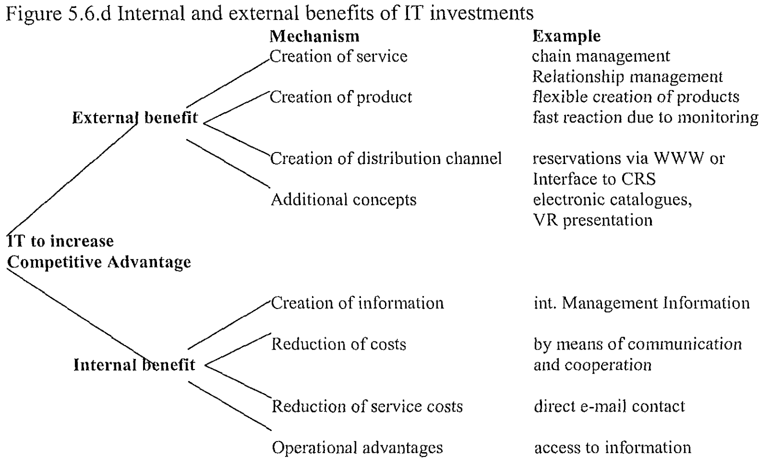
Benefits / Area of impact	Individual	Function	Organisation
Efficiency	**Era II** Task mechanisation e.g. word processing	**Era I** Process automation e.g. payroll	**Era III** Boundary extension e.g. virtual orgs
Effectiveness	Work improvement e.g. d-top publishing	Functional enhancement e.g. inventory info	Service enhancement e.g. booking systems
Transformation	Role expansion e.g. co-ordination roles	Functional redefinition e.g. sales/stock links	Product innovation e.g. selling info

Source: Farbey (1993) adapted from Index Group

Farbey (1993) also developed the concept of the project ladder that identifies eight types of IT projects, each of them delivering different types of benefits at different risks. These categories are: mandatory, direct value added, MIS and DSS systems, Infrastructure, inter-organisational systems, strategic systems and business transformations.

In the hospitality and tourism context, Werthner and Klein (1999) also proposed a framework of ICT benefits, but which corresponds ICT applications with specific benefits based on their explicit use (Figure 5.6.d). However, their framework made evident that critical issues for materialising ICT benefits, e.g. the use of information, systems integration for creating networks that enable critical applications such as relationship management, channel management and seamless integrated distribution channels, communication/cooperation.

Figure 5.6.d Internal and external benefits of IT investments



Source: Werthner and Klein (1999)

Several attempts to classify IT applications into categories based on their use and the benefits that they deliver were analysed. However, classifying IT projects based on their use and benefits can be misleading as the majority of them usually have multiple uses and so, can impact at several organisational levels as well as accrue more than one type of benefit. On the other hand, ICT applications nowadays deliver more than one type of benefit, affect more than one level of the organisation and ICT applications do not have to follow any evolutionary and sequential process, as most of the previous models imply. On the other hand, the previous section illustrated that for materialising ICT benefits organisations have exploited ICT integration capabilities, use the information that ICT produce, re-engineer processes etc.

Recognising the limitations of the previous models regarding ICT benefits measurement as well as the fact that ICT benefits have to reflect the particular use and exploitation of the ICT elements of an ICT application, the following model has been developed and used in this study for relating different types of exploitation of ICT to different productivity gains. The framework is argued to identify all the different ways that the ICT elements of an ICT application can be exploited and so reflect the multiple types of benefits that this ICT can deliver to the organisation.

The proposed model develops upon two concepts. The first concept comes from Venkatraman's (1994) IT enabled transformation model whereby IT benefits were argued to increase while the network capabilities of ICT are being exploited. The second concept emerges from issues regarding knowledge management and the use of ICT to increase the intellectual capital of firms (Stewards 1997, Nonaka and Takeuchi 1995). Knowledge management advocates the use of IT in order to develop a digital nervous system that would support the structural capital of a company, such as the firm's policies, information database and culture, and which in turn would help to enhance the business' human capital - their customer and employee capital. In this vein, the second concept reflects the exploitation of the information element of ICT for delivering organisational benefits. The model can be mapped as in Figure 5.6.e, while Table 5.6.b provides examples of ICT applications that illustrate how ICT systems can be implemented at different levels as identified in Figure 5.6.e.

Figure 5.6.e Framework relating degree of ICT information and network exploitation with productivity gains

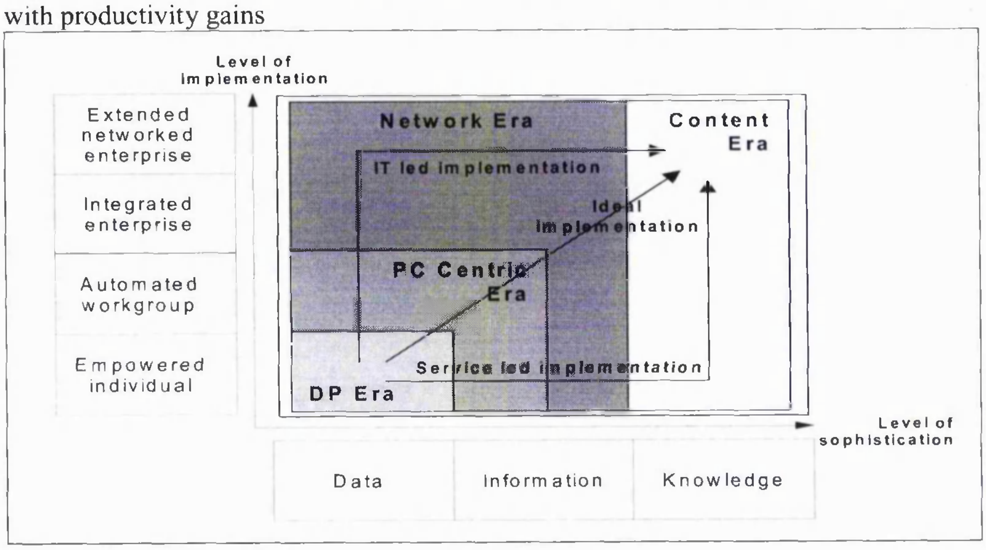


Table 5.6.b Examples of ICT applications at different ICT implementation levels

Extended enterprise	Customer and supplier transactions *on-line sales and other transactions*	Marketing communications *Connect to outside stakeholders*	Ecosystem development *Operate alliances, markets and interests groups*	Market facing systems *Use cyberspace as principal business space*	Customer integration Customer self-service Channel integration Supply chain integration
Integrated enterprise	Enterprise data systems and applications *Build corporate databases and applications*	Enterprise wide communications *Encourage cross functional communications*	Enterprise knowledge Management *Leverage intellectual capital and best practices*	Enterprise process innovation *Reengineering business processes*	Order management or Selling Chain Management E-Purchasing Product development CRM
Automated workgroup	Workgroup data systems and applications *Establish departmental databases & applications*	Workgroup communication *Encourage cross-functional communication*	Workgroup collaboration *Enable collective discovery and decision making*	Workgroup process innovation *Improve conduct and control workflow*	Sales force automation, customer service automation, Internal operations solutions
Empowered individual	Data creation access and usage *Enable user data collection, entry and access*	Information access and authoring *Enable creation access and distribution of information*	Training, education and expertise *Enable creation access and distribution of expertise*	Workflow process innovation *Assure integration into workflow*	Well integrated task oriented IT solutions
	Data	**Info**	**Knowledge**	**Work/wisdom**	

Support operational strategic high potential

In Figure 5.6.e, the vertical axis represents the digital nervous system, which supports the structural capital of hotels. In other words, it represents the systems' configuration and integration with other systems, which in turns reflects organisational level at which the ICT application is being implemented and at which organisational benefits will accrue. The horizontal axis reflects the use of ICT for exploiting and enhancing the human capital of hotels, the employees and guests. It moves from data, to information and knowledge. As the ICT implementation moves in both directions so do the benefits that derive from it. The model also illustrates that ICT applications can be implemented at any level depending on how their ICT elements are being exploited. The latter in turn, will also reflect the orientation of ICT implementation, i.e. whether that is ICT led or driven by demand requirements, as well as whether organisations have managed to fully exploit ICT capabilities that have evolved during the ICT developmental stages, i.e. data era, network and content era.

The usefulness of this framework for fully exploiting ICT applications to deliver enhanced and sustainable organisational benefits in the information era was justified by Sigala et al (2001c). They (2001) specifically used this framework in order to illustrated how the concept and practice of YM can be implemented at different levels depending on the integration levels and use of information and so deliver different benefits.

5.7 Conclusions

Overall, ICT assets were defined and their main constituent parts namely, networks, information and applications were analysed. Based on this analysis two issues were investigated: how developments in ICT assets extend the asset frontier of organisations; how ICT assets are exploited (i.e. ICT management practices) and used in order to change and shift the operating frontier of organisations. As concerns the former, developments in ICT have retooled organisations with enhanced features, namely networks and information, which enabled them to operate in ways that they could not before.

In analysing ICT management practices and their impact on productivity, the exploitation of the network and information capabilities of ICT can boost productivity in the following ways. Management practices aiming at exploiting network capabilities can deliver benefits by improving the efficiency of existing processes, through business process re-engineering, the creation of an organisation-wide database and the improvement of the quality and use of management information. On the other hand, management practices that can improve productivity by exploiting the information element of ICT can be clustered under the following categories: improving business processes; informalisation of processes and products/services; and knowledge management activities. Arguments from several authors and studies supporting the productivity impact of such practices have been analysed and presented.

As productivity gains are directly linked with the degree and way of ICT exploitation, for the purposes of this study (i.e. assess the relationship between productivity and ICT) organisations have to be classified depending on the type and degree of exploitation of their ICT applications. To that end, previous models relating ICT use and productivity gains were reviewed and criticised. Because of their limitations for the purpose of this study, a model for measuring ICT applications that can be directly linked to productivity benefits was proposed, that is based on the two crucial ICT features identified in the previous section. These two dimensions of this framework were used in chapter seven in order to analyse and illustrate how the different level and degree of exploitation of ICT application in the hotel sector can deliver different productivity gains.

CHAPTER SIX

Previous studies investigating the ICT productivity impact

The aim of this chapter is to review and analyse previous studies investigating the ICT productivity impact. This analysis was undertaken in order to after investigating the current state of knowledge in this field to identify how to extend and contribute in this research area. Moreover, this chapter analyses and evaluates the methodology of previous studies in order to identify the advantages and disadvantages regarding the research design that this study could adopt or would need to address.

6.1 Introduction: establishing the ICT productivity paradox

A large number of studies investigating the link between IT investments and productivity are frequently cited and summarised by several authors (e.g. Wilson, 1993; Brynjolfsson, 1993; Hitt and Brynjolfsson, 1996; Lucas, 1993). In fact, the seemingly obvious yet elusive relationship between investment in IT and productivity has accumulated a body of research whose spectrum ranges across a variety of theoretical and methodological perspectives exploring the impact of investment in IT on three different levels i.e. on the economy, industry and at the firm-specific level.

However, despite the plethora of studies, research findings have always led to contradictory and/or questionable results and so, Brynjolfsson (1991) concluded that a profound and sobering conclusion can be derived: our understanding of how IT investments affect productivity at any level (firm, sector, economy etc) is extremely limited. Robert Solow, a Nobel laureate economist, is supposed to have also said that *"PCs are showing up all over the place, except in productivity statistics"*, (in Lucas, 1999, p. 8), while Brynjolfsson (1993) first referred to the concept of the "IT productivity paradox", i.e. the fact that the benefits of IT spending have not shown up in aggregate output statistics.

The debate on the IT productivity paradox has been intensified again recently by the fact that although since the late 1980s the productivity of the manufacturing sector has been rising, the productivity growth of the service sector, in which more than 80% of the capital is IT capital, has become negative (Baily and Gordon, 1988).

In order to illustrate and further elaborate this debate regarding the IT productivity paradox, a variety of studies (both quantitative and qualitative) investigating the relationship between productivity and IT have been compiled and analysed. Moreover, because of the large number of quantitative studies, these are organised into two categories, i.e. those providing some evidence of a productivity impact and those reporting either no effect or a negative one, in order better to highlight the big divergence of research findings. Very few studies have been conducted within the tourism and hospitality industry and these are singled out and analysed separately.

In a following section, the methodological issues of these studies are criticised and investigated. The purpose of this analysis is twofold: a) to gain a clearer view on whether the IT productivity paradox is real or a statistical artefact; and b) to identify the pitfalls of previous studies and so understand how a sound research methodology on the productivity impact of ICT should be constructed.

6.2 Review of previous studies investigating the relationship between ICT and productivity

6.2.1 Quantitative studies

6.2.1.1 Studies with negative evidence

The most compelling evidence for a weak IT productivity effect is found in a longitudinal study conducted by Berndt and Morrison (1992). They constructed aggregated measures of IT capital equipment consisting of office, computing and accounting machinery, communications equipment, scientific equipment etc. for 22 manufacturing firms. They used standard regression techniques in order to estimate the performance changes in two productivity and three profitability measures resulting from incremental increases in IT capital investment. They found that increases in the IT capital stock between 1968-1986 had no differential impact on productivity in comparison to non-IT capital. On the contrary, their results indicated that the marginal benefits of these investments have been only 80% of their incremental costs. Even when they utilised a more sophisticated econometric model that allowed estimation of the value of IT investments in terms of mutifactor productivity and the resulting labour, energy and materials cost savings, the same results were derived. They (1992, p. 3) so concluded that *"the explosion of computer power may have been excessive- on the margin a dollar invested in other types of investment now seems to have a higher return"*.

Berndt et al (1992) conducted another study of the same data set and reported that increases in IT capital stock have been positively related to growth in white collar (non-production worker hours) and that these increases accounted for most of the reduction in aggregate labour productivity reported in their earlier study. They (1992) argued that their findings were consistent with Griliches' (1969) capital-skill complementary hypothesis, which advocated that educated labour is complementary to and not a substitute for advanced IT and so, increases in capital accumulation increases the demand for this labour and prevents its relative price to fall.

Loveman (1988 and 1994) used a microeconomic production function to examine the productivity effects of IT investments on 60 U.S.A. and European manufacturers from 1978 to 1984. The data referred to business units and were gathered from the Fortune 500-sized firms that provided detailed information on IT and non-IT investments and stock, as well as information regarding output, market share, wages etc. Productivity was defined as the increase in output from an incremental increase in IT net of other changes (e.g. in wages, non-IT investment, organisational structure etc). Using sales minus change in inventory as a surrogate for output and various non-IT expenditures, labour compensation, and IT capital as inputs, in most of the econometric models (production function models) that he used, the productivity gain from IT investment was zero (i.e. the output elasticity of IT was negative). He (1988, p.1) so concluded that there is *"no evidence of strong productivity gains from IT investments"*. Despite efforts to find IT effects for subsamples (e.g. for high-IT investors) and careful assessment of model biases and their magnitudes, Loveman could not find a statistically or a substantively significant productivity impact of IT investment.

Loveman's results parallel Weill's findings from a study of 33 strategic business units in the valve manufacturing industry. By examining the impact of IT investment from 1982 to 1987 no relationship was found between IT investment and any of his performance variables (i.e. sales growth, return on assets, ROA and two measures of productivity). To understand better the impact of IT on performance, Weill went one step further by dividing IT investments into three qualitatively different types depending upon the management's intention: 1) strategic IT intended to increase market share or sales (e.g. inventory systems); 2) transactional IT such as accounts payable and order entry; and 3) informational IT, e.g. e-mail, accounting and other IT for infrastructural purposes. His analysis revealed that transactional IT was related to better performance in terms of improved ROA and lowering nonproduction labour adjusted for sales. In contrast, strategic IT investment was not associated generally with performance and in the short term appeared to lower performance on two measures. Informational IT was not related in any way to any performance measure. Thus, Weill's findings suggested that the 22% of IT investment directed into transactional activity has some impact on performance, but the remaining 78% did not. Unfortunately, he did not report the size of the transactional IT effect, only the fact that it was statistically significant (i.e. positive and nonzero).

Another key feature of Weill's model is the conceptualisation of a variable defined as conversion effectiveness, which mediates the relationship between input and output variables. Weill (1992) hypothesized that given the same level of IT investment by any two firms and all other characteristics being equal, i.e. size and structure, the firm with a higher value of conversion effectiveness should achieve higher operating performance. Conversion effectiveness was measured along four dimensions; 1) level of user satisfaction; 2) degree of organisational turbulence; 3) level of top management's commitment to IT; and 4) firm experience with IT. He (1992) reported that firms with a higher conversion effectiveness score were associated with high non-production labour efficiency and sales growth.

In the same vein, Yosri (1992) studied the relationship between IT expenditures (operational, strategic and tactical) and revenue-contributing factors in 31 major firms for the period of 1987-1990. Yosri (1992) found no significant correlation between IT investment and sales growth, market share gain, new market penetration, measures of quality improvement and productivity. Moreover, Dos Santos et al (1993) found that an announcement of innovative IT had a positive effect on stock price, while the announcement of non-innovative IT had a negative impact on stock price. Overall, announcements of investment in IT have no impact on stock price.

Barua, Kriebel and Mukhopadhyay (1993 and 1995) used the database previously used by Loveman (1988) to examine the effects of IT investment on intermediate performance variables such as capacity utilisation, inventory turnover, quality, relative price and new product introduction. Their argument was based on three assumptions: 1) IT effects should be assessed using process-oriented models instead of traditional "black-box" approaches; 2) IT effects should be analysed at the level of a Strategic Business Unit or lower; 3) IT has first order effects on operational level variables which in turn affect higher level performance variables at firm or industry levels. Their study revealed a positive correlation between IT and three of these process measures, but the effects were too small to affect firm-level productivity.

Later, Hitt and Brynjolfsson (1996) used a panel of 370 companies over the period 1988-1992 and tried to replicate previous studies to the degree that it was feasible. They examined the impact of IT spending on return on assets (ROA), return on equity (ROE) and total shareholder return. Even after they introduced controls (i.e. firm specific variables affecting productivity) for the possibility of spurious correlation, the results indicated no correlation between IT spending and total shareholder return, ROA or REO.

In his studies Strassmann (1985, 1990, 1999) concluded that there is no identifiable association between expenditures on IT and profitability, and this relation has not changed for more than 20 years. Although published details of his pilot study of data of 40 large firms are very vague, Strassmann (1985, p. 159-162) reported that there was no correlation between IT costs and his measure of productivity. In a subsequent analysis (1990), he produced a scatter plot based on the findings of 292 companies (from the food and banking industries), but only a random pattern was found between IT investments and return on investment (ROI). As no relationship between amount of IT investment and financial performance was found in any industry, he then (1999) plotted computer intensity against financial performance for some 100 manufacturing and service-sector firms, using survey data published by the magazine Computerworld. Again, in neither the service nor manufacturing firms was financial performance correlated with computer use. The same results were found when survey data from Information Week were used. When the analysis was replicated by using 1994 data for a group of 539 companies, the results were equally disappointing. The results did not change when several different measures of profitability such as return on assets (ROA), return on net investment and economic value added over equity were used. Segmentation of data sets at the industry level did not improve the results.

Strassmann (1990) argued that these null findings do not indicate that computers have no impact at all but they rather suggest that better measures of firm performance and computer use were needed. By developing custom designed measures of performance (using the profit impact of market strategies approach, i.e. the PIMS) he (1990) surveyed 292 predominately manufacturing firms and concluded that: 1) no relationship between IT expenditure and his measure of productivity existed *"over-achievers deliver their results with a level of IT spending equivalent to below average performers"* (Strassmann, 1990, p. 138); 2) in most firms, IT expenditures on MIS dwarfed IT expenditures on operations, on the order of 18 to 1; 3) superior firms, in terms of productivity, spent less than average-performance firms did on IT; 4) some superior performers tended to spend proportionally more of their investments on operations than on MIS. In sum, even with a methodology and data collection tailored to the purpose, Strassmann (1990) found no correlation between IT expenditures and superior productivity and a misallocation of IT investments. The latter is also evident in other studies. Based on his findings, Strassmann (1999) concluded that it is not how much you spend on IT, but how you deploy your IT assets that makes the difference, which is similar to Schmenner and Swift's (1998) performance frontiers theories.

Similar findings and conclusions to those regarding manufacturing have been reported specifically for the service sector as well. Roach (1991) examined the relative changes in output between production workers and information workers and found that although the productivity of a production worker grew 16.9% between the mid-seventies and 1986, information worker productivity declined by 6.6%. He (1991) concluded that the significant IT investments in the service sector during this period have been largely inefficient.

Franke (1987) also reported declines in capital and labour productivity in insurance and banking industries whenever a major technological innovation such as ATMs and PCs, was introduced. He contributed these lower returns on investment on long learning curves, expecting reversal effects in the medium term period.

Osterman (1986) found increasing IT stock to be associated with decreasing levels of employment for managers and clerks in 40 service and manufacturing industries but, he argued that this substitution effect is only temporary. Firms eventually return to the same levels of clerical and managerial employment existing prior to IT.

In a study of 508 branch banks, Banker and Kauffman (1988) reported no evidence of market share growth derived from ATMs at branch banks or by association with a shared regional electronic banking network. They did however report evidence that depositors were willing to pay for network externalities that accrued when a bank was connected to the regionally dominant bank, suggesting a potential competitive advantage.

By studying a representative sample of 58 mutual savings banks of diverse size, Turner (1983) observed different patterns of computerisation among banks (often a function of size) but later, he (1990, p.1) concluded that *"no relationship is found between organisational performance and the relative proportion of resources allocated to data processing".*

Using a quasi-experimental time series design, Venkatraman and Zaheer (1990) observed changes in the productivity of 78 property and casualty insurance agents provided with electronic capability for performing a variety of tasks and functions. Individual productivity was measured as the percentage change in total written premiums prepared before and after automation was introduced as well as changes in the total number of policies in force, commissions and new policies written. However, no evidence of improved productivity six months after automation was reported.

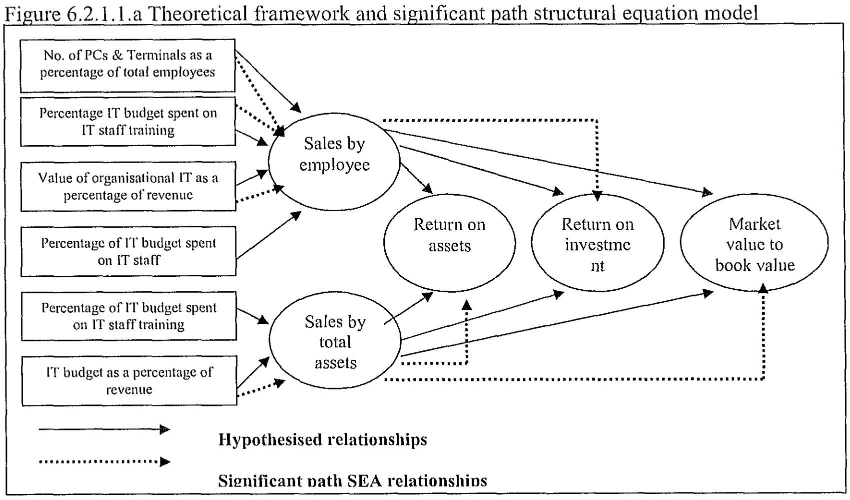
Cron and Sobol (1983) tried to link the extent of computer use (measured primarily by number of software applications) with several performance measures by examining 138 medical supply warehousing firms. An analysis of variance did not reveal a significant relationship between computer use and performance measures and indeed, extensively computerised firms exhibited a bimodal distribution in performance, i.e. they performed either very well or very badly. However, although high versus low performers differed on dimensions such as size and growth rate, a multivariate analysis to control for such variables was not conducted. They, (1983, p. 178) though, concluded that *"extensive and appropriate use of computer capabilities is most likely to be associated with top quartile performance".* Although equivocal, this study must be interpreted as offering evidence suggestive of the existence of a conversion factor as described by Weill (1988).

Byrd and Marshall (1997) investigated the relationship between IT investment and organisational performance by gathering data on IT investment and organisational performance from 350 public companies over four years. Specifically, they used a structural equation analysis to test empirically a theoretical model composed of five IT investment variables and five organisational variables. The model was proposed and constructed by analysing empirical data gathered from the ComputerWorld magazine by Mahmood and Mann (1993) and hypothesised the relationship between four IT investment constructs and a number of organisational performance constructs.

Byrd and Marshall (1997) used this model in order to overcome criticism relating to a lack of a theoretical framework in studies investigating the IT productivity paradox. Byrd and Marshall's (1997) study also has the following advantages: 1) big sample (350 firms); 2) use of IT investment data over a four year period; 3) performance data over a four year period; and 4) performance data are adjusted to reflect a lag of 2 – 4 years from those of the IT investment data. The use of data from multiple years is argued to smooth fluctuations in the respective measures between years, e.g. IT capital investment significantly varies between years, while the latter advantages account for delays in the materialisation of IT benefits. However, Byrd and Marshall (1997) highlighted that the major limitation of their study was the lack of consideration of contextual factors (e.g. size and type of firms).

Figure 6.2.1.1.a illustrates the hypothesised relationships of the framework (indicated by continuous lines between variables) as well as the relationships that Byrd and Marshall's (1997) study found as statistically significant (indicated by dotted lines between variables).

Figure 6.2.1.1.a Theoretical framework and significant path structural equation model



Source: Byrd and Marshall (1997)

Overall, the study found that the variable used to measure the extent to which users have access to IT was significantly and positively related to sales by employee (a measure of labour productivity). Two other IT investment variables, the value of supercomputers, mainframes and minicomputers and the percentage of IT budget spent on IT staff, were significantly and negatively associated with the sales by employee measure. Another IT variable, the IT budget as a percentage of revenue, was significantly and negatively associated with sales by total assets, a traditional measure of capital productivity. The last IT variable, the percentage of IT budget spent on IT staff training, was not related to any performance variable.

Byrd and Marshall (1997) highlighted that the major finding of their study is the following. Financial metrics traditionally used to measure IT investments revealed negative productivity relationships, while metrics that better reflect the use of IT, in this case the number of PCs as a percentage of total staff, gave a positive relationship between IT and performance. In this vein, they (1997) concluded that future studies should use IT metrics that better reflect IT deployment patterns.

6.2.1.2 Studies with a positive evidence

On the other hand, the following studies provided evidence of a positive relationship between IT and productivity. Lee and Barua (1993) employed a different model (incorporating a stochastic production frontier) for assessing the potential impact of IT on technical, scale and allocative efficiency. Their results were strikingly different from Loveman's and consisted of a significant positive relationship between IT capital stock and Strategic Business Unit (SBU) productivity. They also found IT capital and labour to be complementary inputs while IT and non-IT equipment were very strong substitutes. These results appeared consistent with Griliches' capital-skill complementary hypothesis.

Brynjolfsson and Hitt (1993) analysed disaggregated data for 380 large US firms collected between 1987 and 1991 and reported that IT capital investments generate, on average, a 54% return (measured in terms of dollars/sales) for manufacturing and 68% return for manufacturing and services firms combined.

Siegel and Griliches (1991) analysed industry level data and found a positive correlation between industry's level of IT investment and multifactor productivity growth. However, because of concerns regarding the reliability of the government data, the planned more structured econometric analysis was not conducted.

Both Harris and Katz's (1988 and 1990) time series study of 40 life insurance companies and Bender's (1986) analysis of 132 life insurance companies examined the IT productivity impact by using key ratios. Harris and Katz (1990) assessed the relationship of a firm's IT expenditure patterns to its operating cost efficiency, a measure of cost leadership. Their (1990) findings revealed that top performing firms exhibit higher growth in IT expense ratio, e.g. IT expense/total operating expense and lower growth in operating expense than weak performers. Although the relationship was weak, however, it supported the hypothesis that the most cost efficient firms, in comparison to less efficient rivals had higher IT costs per dollar of total operating costs, which in turn suggested a more effective substitution of IT expenses for other operating expenses. However, their analysis was not a causal one as they did not control for other likely predictors of performance such as size.

Bender (1986) also found a positive correlation between higher levels of IT expenditures and high unit cost efficiency, measured as the firm's ratio of expenses to premium income. In fact, the relationship was curvilinear, i.e. firms with very little and a lot IT expenditure were worse performers than those in between. However, investments in application software were positively related to performance and so were investment in hardware. However, although Bender (1986) performed a series of bivariate relationships between a performance measure and one aspect of computerisation he did not assess the combined effects of the various IT aspects (e.g. through regression) on performance, nor did he control for size, market share, type of insurance or other contextual sources of spurious correlation.

In a sample of 159 banks, Alpar and Kim (1991) compared the relative accuracy of the two dominant approaches used by researchers to assess sector, industry and firm-level productivity effects, i.e. the microeconomic analysis and the key ratios correlational analysis (e.g. Bender, 1986; Harris and Katz, 1990). They argued that the advantage of a microeconomic approach in measuring IT value is in being able to estimate not only the effect on profitability but on relative demand for different factors of production. On the other hand, the key ratios assessment is limited in that it does not take into account these other major factors of production when explaining changes in a firm's economic performance. Overall, their findings revealed that: 1) IT was cost reducing – a 10% increase in IT capital was associated with a 1.9% decrease in total costs; and 2) IT was labour-saving and capital-using.

Mahmood et al (1998) used a three-year, cross-sectional analysis (companies from the Computerworld's Premier 100 list for the years 1991-1993) to compare the impact of IT investment from previous years with organisational performance and productivity of the following years. They used cluster analysis to classify firms based on their IT investments, performance and productivity. Their results suggest "to some degree", a relationship between IT investment, performance and productivity. For the three sub-periods in their sample, they find a positive relation between IT investment and change in revenue growth. Results for the relation between IT investment and other measures of productivity and performance were not as clear.

In assessing the impact of IT on business performance, Kempis and Ringbeck (1998) concluded that although IT efficiency (defined as the funds invested on IT projects and project management performance against schedule and budget) is important, IT effectiveness makes a particularly powerful contribution to a company's bottom line. IT effectiveness was defined as the availability, functionality and utilisation of IT for each core business process and it was measured as follows:

- functionality; the number of IT-supported functions or operations in the process being examined;
- availability; the availability of information for users that depended on the availability of IT systems and their degree of integration, with both internal and external IT systems;
- utilisation rate; an assessment of the extent to which the functions provided are used, for which training for IT users was found to be crucially important.

In investigating the IT impact in a sample of aerospace firms, Prattipati (1995) reported that IS investments reduced overhead expenses and increased profit margins. Rai et al's (1996) study also provided evidence of an IT payoff. They specifically found that although the IS budget is not related to financial firm performance, it is positively related to sales performance and concluded that the resulting mix of reported findings highlight the need to learn more about appropriate levels and manner of deployment of IT investments.

A summary of all these studies as well as their categorisation based on the direction of their results (positive or negative contribution of IT on productivity) are provided in Tables 6.2.1.a and 6.2.1.b respectively.

Table 6.2.1.a Research on the productivity impact of IT

Authors	Unit of Analysis	Performance construct and measures	Input measures	Type of analysis	Key findings
Roach (1991)	Service sector	Productivity (employment volume/output)	Total IT Capital Stock	Trend comparisons	Large scale increases in ratio of IT capital stock to other shares of capital, coupled with stagnant productivity, suggest no pay off from IT investment
Siegel Griliches (1991)	Industry (manufacturing)	Productivity (Multifactor)	IT capital Stock	Correlational Time series Cross-section	Found significant effect but concerns over data reliability led them to abandon conduct of a more structured analysis
Franke (1987)	Industry (insurance and banking)	Productivity (average labour)	Total IT Capital cost	Econometric (1958-1983)	Declines in capital productivity associate with specific technological innovations
Berndt Morrison Rosenblum	Industry (20 Manufacturing industries)	Occupational composition of workforce	IT capital force	Econometric Time series Pooled cross-section (1968-1986)	Increases in IT capital investment associated with growth in white collar, non-production hours Skill upgrading in blue collar occupations
Morrison/ Berndt, (1990) Berndt/Morrison (1992)	Industry (20 Manufacturing industries)	Productivity (average labour) (multifactor) Industry profitability (revenue/costs; expost IRR; unit cost markup)	Total IT capital Stock	Econometric Time series Pooled cross-series (1968-1986)	On average, incremental benefits were only 80% of incremental costs IT capital has no differential impact on productivity compared to non IT capital Increases in IT capital associated with increased labour demand Positive impact on industry profitability (unit cost markup)
Osterman (1986)	Industry (40 service and manufacturing industries)	Productivity (clerical employment volume/output) (managerial employment, volume/output)	Aggregated number of mainframes Units of CPU	Econometric Time series (1972- 1978)	Each 10% increase in computing stock associated with 1.8% decrease in clerical employment and 1.2% decrease in managerial employment Found lagged effect; displacement partially reversed after initial impact
Brynjolfsson/ Hitt (1993)	Firm (380 firms)	Productivity (average IS and other labour) Profitability (Revenues/costs; ROI)	Market Value CPU Stock Total US labour expenses	Econometric Pooled cross-section Time series (1987-1991)	54.2% annual ROI for IT capital investment in manufacturing each dollar spent on IS labour yields $2 increase in revenue Productivity paradox disappeared by 1991
Loveman (1988)	Firm/SBU (60 manufacturing SBUs)	Productivity (average labour)	Total ITT capital stock	Econometric Time series Cross-section (1978-1984)	Increases in shares of IT capital have insignificant productivity effects
Harris/Katz (1990)	Firm (40 life insurance companies)	Operating cost efficiency (operating expenses/premium income)	IT expense ratio IT cost efficiency ratio	Correlational Time series (1983-1986)	Top performing firms had higher growth in IT expense ratios and lower growth in operating expense than weak performers
Bender (1986)	Firm (132 life insurance companies)	Operating cost efficiency	Total IT expenses	Correlational Cross-section	Higher IT spending associated with higher unit cost efficiency
Weill (1992)	Firm/SBU (33 manufacturing SBUs)	Profitability (ROA) Competitive advantage (Sales; sales growth) Productivity (Non – production labour/sales)	Total IT capital stock Strategic IT capital stock; Informational IT capital stock	Correlational Cross-section Time series (1982-1987)	No significant relationship between total IT investment and any performance measure) Transactional IT capital cost (23% of total capital) associated with improved ROA. Remaining 78% informational and strategic IT capital stock had no impact on performance

Continued...

Banker Kauffman (1988)	Firm/SBU (508 branch banks)	Competitive advantage (marginal bank branch deposit share as contribution to reducing costs)	Presence of ATM at a branch Connection to regional shared ATM network	Econometric Cross-sectional	Use of ATM's enable branch to protect rather than grow market share Bank customers evidenced willininginess to pay for regional access to shared electronic banking network externalities
Alpar/Kim (1991)	Firm/SBU (759 Banks)	Productivity (multifactor)	Total IS expenses Labour Capital Time deposits	Econometric Time series Cross-section (1979-1986)	10% increase in IT associated with a 1.9% decrease in total costs IT contributed to reduction in demand deposit amount and an increase in time deposits IT is capital using and labour savings
Barua, Kriebeland Mowkhopahyay (1993)	Firm/SBU (60 manufacturing SBUs)	Competitive advantage (operational/function al performance, i.e. capacity utilisation, inventory turnover, quality, relative price and new product rate) Profitability (ROA;Market share)	IT capital stock	Econometric Time Series Cross section (1978-1984)	IT capital positively and significantly affects intermediate performance variables Increases in IT capital do not affect ROA
Lee/Barua (1993)	Firm/SBU (60 manufacturing SBUs)	Productivity (average labour) multifactor	IT capital stock	Econometric Pooled cross-section Time series (1978-1984)	Increases in IT capital shares have significant effects on SBU by reducing technical and scale efficiencies IT capital stock is more productive than no IT capital stock
Cron/Sobol (1983)	Firm (138 surgical wholesalers)	Profitability (ROA; Profits/sales; return on net worth) Competitive advantage 5 years sales growth	Number of software applications	Correlational Cross-section (1979)	Firms with extensive automation are either very strong or very weak financial performers
Venkatraman / Zaheer (1990)	Individual (78 insurance agents)	Productivity (number policies in force; number of new policies) Effectiveness (total premium and commissions)	Electronic integration with insurance carriers	Quasi-experiment Time series (1985-1987)	No improvement in operating efficiency No improvement in effectiveness
Strassmann (1985, 1990, 1999)	Reanalysis of the same dataset from Computerworld and Newsweek	Profitability (ROA, ROE, return on net investment, economic value added over equity)	IT capital expenditure	Regression correlations	No impact on profitability
Mahmood et al (1998)	100 first firms of Computerworld between 1991-1993	Organisational performance and productivity	IT capital investment	Cross sectional Time series	Positive relationship between IT expenditure and change in revenue growth No impact on other productivity metrics
Kempis and Ringbeck (1998)	Sample of USA companies	Organisational performance and operational efficiency metrics	IT efficiency IT effectiveness	Regression	IT effectiveness has a higher impact on performance and operational efficiency metrics than IT effectiveness
Prattipati (1995)	Sample of aerospace firms	Profitability and productivity metrics	IS capital investment	Correlations	IS investments reduced overhead expenses and increased profit margins

Continued...

Rai, (1996) Patnayayakuni &Patyayukuni	210 firms	Organisational performance	IS capital investment	Correlations	IS budget is not related to financial performance, but is positively related to sales performance
Byrd and Marshall (1997)	350 USA public companies	Five organisational performance variables: sales by employee, sales by total assets, return on sales, ROI, market value to book value	No. of PCs/ total employees, % of IT budget spent on IT staff training, value of IT/revenue, % of IT budget on IT staff, IT $ / revenue	Structural equation analysis (SEA)	Some relationships in the SEA were confirmed but with a negative direction

Table 6.2.1.b Does IT have a measurable productivity effect?

Confirming evidence	Disconfirming evidence
Siegel/ Griliches (1991)	Roach (1991), Yosri (1992), Dos Santos et al (1993)
Brynjolfsson/ Hitt (1993)	Franke (1987), Hitt and Brynjolfsson (1996)
Harris/Katz (1988) and (1990)	Berndt/Morrison /Rosenblum (1992), Mahmood et al (1998)
Bender (1986)	Osterman (1986)
Alpar/Kim (1991)	Loveman (1988) and (1994)
Lee/Barua (1993)	Weill (1988) and (1992)
Kempis and Ringbeck (1998)	Banker / Kauffman (1988)
Prattipati (1995)	Barua / Kriebeland/ Mowkhopahyay (1993) and (1995)
Rai, Patnayayakuni and Patnayayakuni (1996)	Cron/Sobol (1983)
	Venkatraman / Zaheer (1990)
	Turner (1990)
	Strassmann (1985), (1990), (1992) and (1999)
	Byrd and Marshall (1997)

6.2.2 Qualitative studies

On the other hand, qualitative studies have shown a more consistent pattern to their results when examining the relationship between IT and organisational performance. Indeed, qualitative studies typically show a positive relationship between IT and organisational performance. For example, Caron et al (1994) reported benefits such as improvements in cost, improvement in quality and better customer service – among other benefits – at CIGNA corporation after a series of IT-driven reengineering projects were completed at the company. Palvia et al (1992) studied an advanced multi-technology system for personnel and organisational functions, finding significant increases in cost savings and employee empowerment leading to significant organisational effectiveness benefits.

Newman and Kozar (1994) related the benefits of the intelligent, multimedia system MEDUSA that helped Zale Corporation, a reseller of jewellery, save hundreds of thousands of dollars. Instead of melting down discontinued, damaged or repossessed fine jewellery, thus losing a large percentage of the value of the jewellery, Zale adopted MEDUSA to yield strategic information that provides for much more sophisticated management of a valuable corporate asset. In another study of IT impact on a company, Mukhopadhyay et al (1995) found that an electronic data interchange (EDI) implementation at Chrysler, the giant US automobile manufacturer, saved the company at least $100 per vehicle in tangible benefits and probably much more from the intangible benefits. Belcher and Watson (1993) reported that CONOCO reaped tremendous benefits in improved productivity, improved decision-making, information distribution and software replacement cost savings and several other tangible benefits from the implementation of an executive information system (EIS).

These are only a representation of case studies where IT investment has produced significant benefits for the adopting companies. However, although there are a few cases, as reported in Lyytinen and Hirschheim (1982), citing dysfunctional effects, Byrd and Marshall (1997), after reviewing the literature, argued that the overwhelming number of case studies investigating the benefits of IT report measurable positive effects. However, Byrd and Marshall (1997, p.52) highlighted one major limitation of qualitative studies by arguing that *"...it seems that most qualitative studies report only on systems that provided positive contributions for their companies, even though we know that some IT implementations are failures"*.

Kerlinger (1986) also identified a few of the validity threats of qualitative studies: 1) inability to manipulate independent variables; 2) risk of improper interpretation; and 3) lack of power to randomise. Other researchers (e.g. Lee, 1989) noted shortcomings such as lack of controllability, deductibility, repeatability and generalisability.

6.2.3 Studies investigating the IT productivity impact in the tourism and hospitality industry

It has been an implicit (i.e. when datasets were clustered and analysed for each industry separately) as well as an explicit (e.g. Brynjolfson (1991) claimed that IT productivity gains are highly contextual and industry specific) recognition in previous studies that the impact of ICT on productivity is different depending on the type of the industry. On the contrary, despite this as well as the fact that ICT is a vital and critical tool for tourism and hospitality businesses, only a very small number of studies on IT productivity impact are found in the tourism and hospitality industry.

In surveying hotel managers' perceptions of the impact of IT on hotel productivity, David et al (1996) reported that the hotel managers believed that some IT applications (e.g. reservation management systems, rooms-management systems and guest-accounting modules) have improved the productivity in the hotel industry, while others (e.g. in-room information, vending and entertainment, as well as automated check-in and check out devices) have decreased productivity. Research findings are, though, limited since they are based on managers' perceptions of the expectations and outcomes of IT investment rather than hard data.

In investigating the impact of IT on hotel productivity, Liu (1995) and Baker and Liu (1996) obtained financial performance data from 29 Taiwan hotels and found that a significant correlation between past IT investment and corporate performance was not established, but they acknowledged problems in terms of isolating the contribution of IT from other factors on business performance and in developing a satisfactory measurement of aspects of business performance. Because of these limitations they argued that further research on IT productivity impact should consider that: a) it is the effective use of IT and not IT investment per se that has the ability to increase overall revenue, improve customer services and increase manpower productivity in hotel operations; and b) there should be positive user attitudes to the potential advantages of the use of IT in order for IT benefits to materialise.

Cho and Olsen (1998) applied a case study methodology in order to investigate the impact of IT on competitive advantage (defined as efficiency of primary and support activities, resource management functionality, threat, preemptiveness and synergy) in the context of the hotel industry. Their research findings revealed that top managers are fully aware of the importance of IT, but currently they regard IT as a necessity for operations rather than as a strategic weapon. Indeed, IT applications were used in order to reduce costs by improving the efficiency of operational activities more than to generate revenues by providing better and convenient service to customers, or to alter bargaining power with customers and suppliers and to threaten competitors. Measurement and management of IT returns and a strategic posture toward IT were suggested to be essential *"if hotels want to create a new way of doing business and obtain substantial benefits by using IT",* (Cho and Olsen, 1998, p. 393).

In surveying Small and Medium Hospitality and Tourism Enterprises (SMHTEs) managers' perceptions on the impact of multimedia on employment, Sigala et al (1999 and 2001b) reported that ICT were not perceived to have any significant effect on employment levels whereas stronger positive perceptions were found in terms of the impact of multimedia on the nature, content and skills' requirements of existing staff. When statistical tests were applied to different managers' groups in order to investigate whether any statistically significant differences existed among respondents' perceptions, they (2001) reported that the impact of multimedia was very contextual and situational dependent. Specifically, four factors were found to affect managers' perceptions of the employment impact of multimedia namely, size and type (B&B, hotel etc) of organisation as well as number and level of use of multimedia. Coupled with the fact that findings were only based on subjective data (managers' perceptions), Sigala et al (2001b) concluded that further and more structured research is required in order accurately to assess the impact of multimedia.

Overall, the review of these studies provides a sense of the achieved progress in producing empirically based explanations of how IT investments affect productivity growth. A mix of aggregated and disaggregated datasets has been used. The literature review also exhibits a great breadth of the use of multiple methods and research designs (e.g. correlations, econometric models) as well as reanalyses of the same datasets used in previous studies but which incorporate different behavioural assumptions and econometric specifications. However, despite the plethora and variety of the studies and the very large investments in IT, it was shown that productivity payoffs are elusive. Several of the empirical studies reviewed did not find any productivity or other performance payoff from IT investments. No study documents substantial IT effects on productivity, while studies that do provide evidence have not controlled for contextual factors (e.g. size). It is this lack of a clearly observable and substantial IT payoff, given the very large investment in IT, that raises the question of an IT productivity paradox. On the other hand, the existence of the IT productivity paradox is being debated basically because the validity and reliability of previous studies is questionable. Because of that as well as in order to investigate how a sound methodological research on the IT productivity impact can be built, debates regarding methodological issues and problems of research investigating the IT impact on productivity are analysed below.

6.3 Unravelling the IT productivity paradox: methodological issues of studies on the ICT productivity impact

It has been made evident from the previous analysis that previous research gives non - conclusive evidence for the impact of IT on productivity. However, findings of past studies have been questioned on methodological grounds such as: a) use of inappropriate measures of IT intensity, b) failure to control for other factors that drive firm productivity and c) problems related to sample selection and sample size (Dos Santos et al, 1993; Hitt and Brynjolfsson, 1996; Lucas, 1993; Mooney et al, 1995). Moreover, several studies (e.g. Beath et al, 1994; Grabowski and Lee, 1993; Lucas, 1993; Markus and Soh, 1993; Sambamurthy and Zmud, 1994) have attributed the inconclusiveness of the impact of ICT on business performance on the lack of conceptual frameworks and so stressed the need for better theoretical models that trace the path from IT investments to business value.

Because of these, several journal articles, debates and studies have attempted to determine whether the contradiction of the IT productivity paradox is a statistical artefact or a real phenomenon and several explanations are given for the inability to find a relationship between IT and productivity. Harris (1994, p. 24) advocated that the negative findings on productivity are artefacts meaning that *"they stem from inaccurate data or methodological problems rather than from a short fall in IT effectiveness"*. Menon (2000) argued that the unravelling of the paradox requires an understanding of the computer revolution, i.e. the availability of new capabilities and features of ICT and their impacts in organisations. David (1990, 1991) related the computer revolution to the technological revolution fostered by the invention of the dynamo. He (1991) claimed that although analysts predicted dramatic changes in the technoeconomic system due to dynamos the fruition of these changes did not occur until changes on factory plants and work environments were successfully implemented. Similarly he claimed that the slippage between the advancing frontier of technology and actual practice can only be overcome by significant reorganisation and reconfiguration of productive activity over a period of time.

Brynjolfsson (1993) proposed four non-exclusive explanations for the IT productivity paradox: 1) mismeasurement of inputs and outputs; 2) lags due to learning and adjustment; 3) mismanagement of information and technology; and 4) redistribution and dissipation of profits, i.e. that "IT rearranges the shares of the pie" in favour of some companies "without making it any bigger". Bakos (1998) offers an alternative list of possible explanations for the productivity paradox, listing mismeasurement, mismanagement, diffusion delay and capital stock theory as the four "prominent hypotheses" for the explanation of the paradox. Although diffusion delay is another name for Brynjolfsson's lags, Bakos (1998) replaced Brynjolfsson's explanation called as "redistribution" with Oliner and Sichel's (1994) "capital stock theory". According to the latter, in spite of the recent spending on IT, IT's share of capital stock is still small. This is because firms have only recently started investing heavily in IT, and by nature, IT tends rapidly to become obsolete, which in turn makes it difficult for researchers to observe the impact of IT investment on financial performance. However, in all likelihood, the productivity paradox is due to a combination of factors, (Brynjolfsson, 1993; Bakos, 1998).

Wigand et al (1997) grouped the various explanatory approaches for the IT productivity paradox into seven categories as follows:

- Reinvestment of employee-related savings;
- Redistribution of gains among the firms within a business area;
- Delay in realising gains;
- Inadequate measurability of inputs and outputs;
- Political obstacles;
- Mismanagement of information and technology;
- Insufficient reorganisation of organisational processes.

Indeed, studies that tried to address the explanations of the productivity paradox provide more conclusive results on the relation between IT investment and productivity. For example, by focusing on one of the four explanations for the productivity paradox (and specifically the mismeasurement problem), Brynjolfsson and Hitt (1996) were able to show a significant relation between investment in information systems and firm output. Stratopoulos and Dehning (2000) empirically tested and validated the proposition that mismanagement is another viable explanation for the productivity paradox. Using a quasi-experimental design with data gathered from the premier 100 list companies ranked by the Computerworld, they examined to what extent companies that have been recognised by industry experts and their peers as successful users of IT will experience statistically significant performance advantage relative to their competitors. Their empirical results provided statistical support that successful investment in IT leads to superior financial performance, e.g. gross profit margin, growth of net sales, and efficiency gains, e.g. total assets turnover, inventory turnover.

It is so made evident that the methodological advantages and disadvantages of research on the productivity impact of IT need to be analysed in order to: a) better understand and evaluate findings of previous research; and b) construct a methodologically sound research study from which reliable results can derive. To that end the following section discusses debates on the methodological issues of previous research by grouping them into two broad categories: a) mismeasurement problems and b) mismanagement problems.

6.3.1 Mismeasurement problems

Mismeasurement problems affecting the quality of research on the productivity paradox refer to debates regarding methodological issues related to: a) the quality of the data used and of the data analysis; b) the metrics measuring productivity; c) the metrics measuring IT; d) the level of analysis at which research is undertaken; and e) the statistical method relating IT with productivity. These are analysed as follows.

6.3.1.1 The quality of the data used and of the data analysis

Unfortunately, a few research studies have relied on data gathered for other purposes and whose reliability is questioned (e.g. Computerworld, Information Week etc). Moreover, studies such as these of Strassmann (1990), Loveman, (1988) and Weill (1988) are vulnerable to other methodological objections. This is because findings in which parameter estimates are not significantly different from zero should have been assessed in light of the statistical power of the sample. Small samples (e.g. 40 cases) can produce estimates of zero or nonsignificant estimates for IT, not because IT has no effect, but because the sample size is so small.

In addition, some studies provide evidence for some payoff, but either used research designs that did not control for important sources of spurious correlation or did not document the size of the productivity payoff. It is important for future research to disentangle the effect of contextual factors as well as the nature and size of the effect (if any) of IT investments. Specifically, Byrd and Marshall (1997, p. 55) argued that *"future quantitative research should incorporate the contextual features of qualitative research studies so that we can discover what organisational factors are important in facilitating a positive relationship between IT investment and performance".*

Another methodological point regarding data analysis is that IT can have quite different effects on productivity in high performance firms compared with low-performance ones. Indeed, Barua et al (1989), Cron and Sobol (1983), Strassmann (1985 and 1990) suggested that the IT has quite different effects on productivity in high performance firms compared with low-performance ones, as the introduction of IT into poorly run firms does not increase productivity, whereas the introduction of IT into well-run firms pay-off. This is the well-known *"amplifier effect"* of IT, meaning that ICT reinforces existing management practices dividing firms into very high or very low performers. The implication of the amplifier effect is that there might be a bimodal distribution of productivity outcomes in which firms cluster at two extremes: low and high computerised firms, which both include good and poor performers. According to the previous argument any relative IT impact in good firms is balanced out by IT's negative effect in poorly run firms and so the overall (and misleading) impression is thus, that IT has no effect. Because of that, it is crucially important that research studies first distinguish between bad and good performers and then investigate the productivity impact of IT on both types of performers.

6.3.1.2 The metrics measuring productivity

Although several explanations have been given to the IT productivity paradox, the most commonly cited reason is the use of inappropriate productivity measures. In particular it has been argued that because of the extensive variety of ways businesses are deploying IT, traditional financial metrics are not considered as adequate for assessing the full impact of IT. For example, in reviewing the empirical literature on IT value, Brynjolfson (1993) concluded that traditional measures of the relationship between inputs and outputs fail to account for non-traditional sources of value. And indeed, nowadays, IT investments are made for a variety of reasons and so, different IT benefits accrue to various stakeholders of a firm (e.g. customers, employees, suppliers) such as improved quality, increased variety of products and/or services, better and faster responsiveness to customer needs. Moreover, because IT is no longer confined to an isolated area but is permeating the whole value chain in modern business, these stakeholder benefits are becoming more significant. This is particularly true for information systems that extend beyond the boundaries of a single firm, e.g. reservation systems, procurement systems.

On the other hand, Hitt and Brynjolfsson (1994, p. 263) argued that the majority of studies to date have omitted many important classes of such benefits and after illustrating that there are three related but distinct facets of IT's on impact a firm namely IT's ability to affect productivity, business performance and consumer value, they strongly claimed that "*...seemingly contradictory results are not contradictory at all because different questions were being addressed*". In other words, Hitt and Brynjolfsson (1994) advocated that the debate over the IT impact is muddled by confusion as to what question is being asked, i.e. the variable that is supposed to be measured for investigating the IT's impact. This in turn implies that research studies on the IT productivity paradox should clearly identify the IT impact that they are investigating and then develop robust metrics for measuring the latter. That is to say that methodologically sound research on the IT productivity paradox crucially depends on the conceptualisation and measurement of productivity.

To illustrate their argument, Hitt and Brynjolfsson (1994) used the theory of production, theories of competitive strategy and the theory of the consumer as the three theoretical frameworks empirically to measure and test IT's impact on productivity, business performance and consumer value respectively. Findings indicated that IT increased productivity (efficiency only, i.e. the conversion of inputs to outputs) and consumer value while business performance (profits, return on assets and return on equity) was negatively or not affected. Hitt and Brynjolfsson (1994) argued that there is no inherent contradiction with these results and that they are consistent with economic theory. However, although Hitt and Brynjolfsson (1994) clearly illustrated that the contradictory results of previous studies are not contradictory, they failed to illustrate the dynamic interrelationships that exist between these three concepts. For example, productivity can increase not only through applying IT to decrease production costs but also when greater outputs or fewer inputs accrue as a result of the use of IT to support the business strategy or to produce customer value added (new service).

Quinn and Baily (1994) also highlighted that there is a measurement problem in longitudinal studies that show an IT productivity paradox by providing two reasons. First, productivity measures ignore many critical dimensions, as they do not reflect the "alternative cost" of what would have happened without the IT investment. Second, IT enabled service companies (e.g. airlines, travel agents) to provide much more complex, rapid, effective service and to pass along many performance improvements but their margins have been limited because of competition and commissions. Quinn and Baily (1994, p. 32-33) also identified the following categories of "alternative costs", gains or losses of IT investments, which they argued cannot be reported in firm metrics and financial data:

- Maintaining market share. Market share is an important factor of performance success as well as a basis for marketing, purchasing and competitive power. However, IT investments that only maintain market share may display little or no incremental benefit at the company level.
- Avoiding catastrophic losses. IT investments that successfully prevent very large losses- security systems, fire prevention systems- are economically rational, but will show up as measurable company productivity.
- Creating greater flexibility and adaptability. IT investments are essential elements in infrastructure that allow companies to survive despite rapid and unforeseen changes in the external environment, e.g. airlines without well developed reservation systems and operating IT infrastructures survive the rapid adjustments

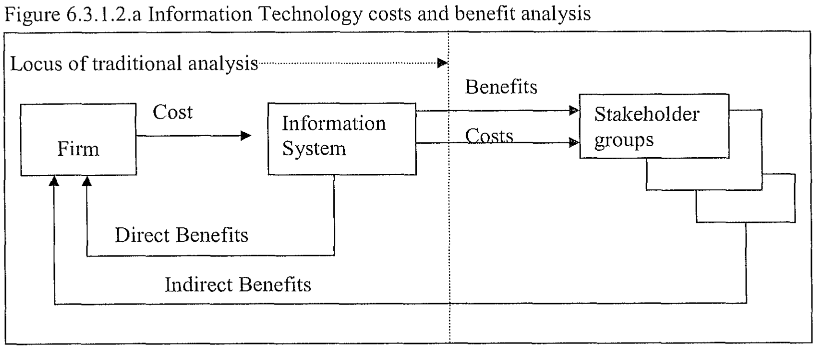
forced by deregulation. Such investments enabled survival, but not necessarily higher profits than before.

- Improving responsiveness for new product lines. IT is essential for service companies attempting to maintain or lower costs while expanding the variety and geographical outreach of their services, e.g. electronic distribution channels economically and with increasing returns expand the points of sales of hotels. Yet competition has decreased the average margins for the tourism industry.
- Improving service quality. IT is critical element in creating better customised or individualised services, improving reliability, ensuring more consistent levels of performance, minimizing errors and freeing contact people for personal interactions with customers. While these benefits may ultimately show up as improved customer loyalty and lower marketing costs, they may or may not be translated to financial benefits.
- Enhancing quality of work life. IT helps eliminate burdensome tasks, makes jobs more attractive, shortens training cycles and improves morale. Although substantial benefits may be shown in employee turnover, the impact of the latter on productivity measures may be little or none (as employees expectations are rising and assume such things as standards across industry).
- Increasing predictability of operations. IT is a valuable tool in predicting sales, controlling inventories and reducing fluctuations in revenues, profitability or employment (rates and room inventory control with yield management systems, employees scheduling systems etc).

Companies with any of these problems would clearly lose productivity and competitiveness without adequate IT, but it is impossible to measure the exact benefit they achieve or to assign benefits to IT alone. However, as has been discussed in the productivity chapter, such outputs represent intermediate results or soft/quality (top line factors) issues that ultimately result in final and aggregate productivity outcomes. So, although it may not be possible to measure separate outputs, these are incorporated in final aggregate metrics. Moreover, there is no point in investigating and assessing IT impact on intermediate outputs if the latter do not result in final outcomes. Moreover, it is evident that a cross-section study within the same industry would also count for the "alternative cost" of IT, as it benchmarks performance between IT and non-IT users. In other words, the hidden or "alternative costs" of IT investments are expected to make hotel IT users outperform hotel non-IT users.

Regarding productivity measurement problems, Jurison (1996) provided a totally different explanation for the IT productivity paradox. He argued that an explanation to the IT productivity paradox is not so much the omission of such "stakeholders" or "soft" benefits but rather a bad intervention and guidance from business management in order to capture these benefits in the bottom line. In particularly, he argued that the key to getting the best return on IT investment lies in "*active management of a portfolio of benefits that are distributed across several stakeholders groups and particularly the distribution of benefits within the portfolio*" (Jurison, 1996, p. 265). He thus went on to propose a descriptive model for analysing the creation and distribution of IT value among the various beneficiaries that would help in the development of a set of guidelines for effective management intervention. Jurison's model is illustrated in Figure 6.3.1.2.a. IT investments create direct benefits to the firm and a set of benefits to the stakeholders, some of which can be recovered by the firm as indirect benefits. However, costs are incurred for both the firm and the stakeholders. Lucas (1999) also identified two types of IT benefits, direct savings or/and generate additional revenues and indirect effects (e.g. second order benefits to the customers through better products/services), which may be reflected as increased market share or a strategic advantage.

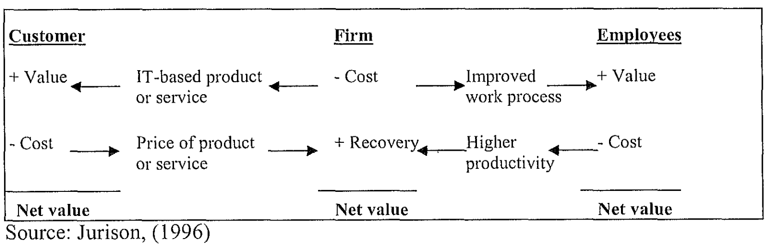
Figure 6.3.1.2.a Information Technology costs and benefit analysis



Source: Jurison, (1996)

Figure 6.3.1.2.b illustrates a more detailed example of the nature of cost and benefits for two specific stakeholders groups: customers and employees of the firm (however, the concept applies equally well to any number or type of stakeholder groups). The way that stakeholders' benefits translate to increased firm performance is as follows.

Figure 6.3.1.2.b Stakeholder-based information technology value model



Source: Jurison, (1996)

The firm by investing in IT incurs a cost and creates value internally as well as to both stakeholder groups.

The value to customers may be in a better product, service or lower cost. If the value to customers is higher than the price charged by the firm (net value= value created – cost) they will buy the product or services and the firm will recover a part of its investment through increased sales and profits.

The amount of benefits that can be recovered by the firm is largely influenced by the firm's competitive environment, because although significant benefits may accrue to customers, competition may prevent the recovery through increased sales and profits. For example, when competitors are able to match the new product/service, most of the benefits are permanently captured by the customers. This argument is similar to claims that because of imitation IT investments do not guarantee sustainable competitive advantage and increased firm performance unless the firm is able to create technological or other types of barriers to entry. It is so usually the case that IT benefits accrue only temporarily to first movers and then eventually work in the customers' favour due to competitive pressures. In some cases IT costs can also be recovered by transferring some internal costs to customers. This is often in service industries by making customers pay in terms of personal labour and waiting time. For example, many hotel customers perform the functions of front office staff at automatic check-in/out teller machines. These customers benefit from increased convenience, but at a cost of doing some of the work themselves, allowing the hotel to benefit from reduced labour costs.

A firm can also create value to its employees by investing in IT. The added value may be in the form of more effective work processes, allowing the workers to accomplish their work in less time or with less rework. But the firm must eventually recover some of the value in order to earn sufficient return on investment. This can be accomplished through cost displacement (performing the same amount of work with fewer employees) or cost avoidance (performing more work with the same number of employees). No matter the form of the recovery, it is a cost to employees that reduces their net value from the investment.

In this vein, Jurison (1996, p. 269) argued that the key to managing and materialising IT impact successfully *"lies in understanding where value is created and establishing recovery mechanisms that will produce an appropriate balance of benefits among all beneficiaries".* IT can create only a potential for value and whether this potential is realised depends on how effectively the benefits are managed for business results. *"Without an effective benefits management process benefits will be dissipated among various stakeholders groups leaving the investing organisation without satisfactory payoff",* (Jurison, 1996, p. 271). Brynjolfson (1993) also argued that in many cases, the limited return on IT investment is caused by management's failure to bring the benefits to the bottom line. For example, in the case of US financial service industries, Jurison (1996) argued that most of the benefits from IT investments in the past went to the employees and only recent competitive pressures from global service providers have shaken management from complacency to take the necessary tough measures to reduce the size of the workforce and bring the benefits to the bottom line.

In this vein, the balance of benefits explanation to the IT productivity paradox provided by Jurison (1996) is argued to be compatible with the arguments advocating that IT delivers intermediate benefits which although they cannot be easily measured and identified, their effect is incorporated and reflected in final metrics. In other words, the recovery mechanism can also be thought as a management process of ensuring that intermediate outputs are translated to final outcomes. However, this approach in turn implies that the IT productivity paradox is more a productivity management problem than a measurement problem, that is to say that if the relationship between IT and productivity is found elusive that is not because the IT's impact has not been measured but that management has failed to materialise it.

The distinction between intermediate and final IT gains is also evident within the MIS literature. From the latter approach, the success of ICT projects are also evaluated from a number of perspectives such as systems quality, information quality, the rate of the use of the system, user satisfaction, individual impact and organisational impact (DeLone and McLean, 1992). However, the former five are considered as internal to the firm in the sense that these are indicators of performance of intermediate business processes that lead to the realisation of one or more final organisational goals(s). On the other hand, organisational impact is a direct indicator of the impact of IT on the realisation of the final organisational goal and subsumes the effects of the other five success measures. Organisational impact of IT *"indicates the impact of IT investments or usage in relation to the organisation's external environment such as markets, consumers, competition etc."* (Menon, 2000, p. 5). Brancheau and Wetherbe (1987) also reported that IS practitioners rated organisational performance higher than the other five metrics as indicators of the IS performance impact.

These arguments regarding the successful management and materialisation of IT productivity benefits are also confirmed by Siguaw and Enz's (1999) study in investigating best practices in IT within the USA hospitality sector. The vast majority of the reported best practice champions focused primarily on using IT to improve the efficiency of internal operations. The indirect effect on customer service and guest satisfaction was a secondary goal (but in some cases, a happy accident). Thus, for the most part, the best practices related to IT involved streamlining operations by reducing paperwork, speeding information dissemination and increasing employee productivity – thereby increasing hotel profitability and productivity. Other practices entailed collecting more detailed data on guests or providing more data to reservations agents (both for the purpose of increasing sales), while few practices emphasised using IT for the sole purpose of upgrading guest services.

Table 6.3.1.2.a gives a detailed analysis of the reported IT hotel best practices from which the following comments can be made:

- The majority of IT best practices concentrates around hotels that implemented IT in order to improve productivity and hard performance metrics. This may contribute to the focus of the industry to assess and approve IT investments based on the hard benefits of IT that can also be easily identified. However, it clearly illustrates that the primary goal of IT investments in the hotel industry is to improve productivity and efficiency.
- It is also evident that best-practice champions do not differ in terms of investments in IT systems. What actually differentiates them is how they use these systems, which confirms the argument that it is not IT that adds value but its deployment that is important.
- Despite the fact that some best–practice champions claimed to have introduced IT for the purpose of increasing guest service and satisfaction they reported to measure the success of their IT investment by hard metrics, i.e. increased revenues, occupancy rates as well as soft metrics i.e. guest satisfaction and morale. This shows that even if IT is introduced for the purpose of enhancing customer service the underlying and ultimate aim is to increase results at the bottom-line. By this way, soft benefits are regarded as metrics of intermediary targets (e.g. customer service) that are assumed to lead to increased overall productivity and performance. The hotel industry's preoccupation to use IT for purposes of better guest service that would in turn result in enhanced performance is also illustrated by the fact that companies that have pursued IT to solve guest-

service problems have done so *"knowing that the solution would benefit the overall operation of their hotels at the same time"* (Siguaw and Enz, 1999, p. 70).

- It is also evident that hotel operators measured the success of their IT systems not only by specific metrics, e.g. reduced errors, improved quality, increased morale, increased travel participation and improved response time but also by overall bottom-line metrics such as increased profits, reduced costs, increased Average Daily Rate (ADR). This reflects the fact that it is actually not important how IT (i.e. which specific intermediary metrics) will drive improved performance, but rather whether IT has an ultimate effect on the bottom-line. If use of IT does not improve bottom-line results it is difficult to justify its success and reason for implementation.

Table 6.3.1.2.a Overview of IT best-practice champions

IT Champion Title of case	Description of case	Method of implementation	Measure of success
IT to improve guest service			
The Balsams Grand Resort Hotel A guest History System	Created a comprehensive guest-history program that tracks each guest's preferred room, room layout, dining room, server, food and beverage items, housekeeper and activities.	Each time an individual telephones or stays at the property, requisite information is entered into the guest-history database system. If the caller is a previous guest, that person's file is pulled up and the data reviewed and updated. The system is fully integrated with operations.	High occupancy rates from return guests and word-of-mouth recommendations
Ritz-Carlton Chicago "Compcierge" position to handle guests' related problems	Created new "compcierge" staff position within the MIS department to serve guests who are experiencing computer technology difficulties and to provide computer equipment on a loaner basis.	MIS personnel handle guests' computer-related problems as an added service to guests. Additional hardware and software were purchased to meet guests' needs and requests for new software are reviewed immediately to determine feasibility. The compcierge desk, found in front of the hotel's business center and operates 9 AM to 6 PM, Mondays through Fridays.	Increased customer satisfaction and increased morale among concierge, business centre and MIS personnel
Candlewood Hotel Company Electronic Record Management	Implemented an electronic system of recording and storing ("imaging") virtually all accounting and construction records, thus eliminating the need to file and store hard copies of documents.	Worked with software providers to find a system that would be easy to use. As part of the document-processing procedure, the document is scanned into the system and retrieval is easily accomplished via a file-index program.	Increased productivity and reduced labour costs; improved response time to vendors, guests and employees and decreased storage costs
Cendant Corporation Integration of all hotel MIS functions	Computerised system developed to integrate all hotel MIIS functions into one system, so that all 6,000 franchised hotels can use the information contained in Cendant's huge database.	The activities of property management, central reservations, internet communications and direct marketing are integrated into one system.	Increased franchisees' ADR and corporate profits; and increased capability to serve customers
Fairmont Copley Plaza Hotel Using a Property Management System to improve concierge Desk excellence	The property-management system supports concierge services with a database that places guest information at the concierges' fingertips, thus freeing them for more direct guest contact.	The PMS records each guest's preferences and reminds the concierge of guests who need special attention. It also contains area restaurant schedules and attributes and is capable of printing directions for guests.	Increased guest satisfaction and loyalty
Hotel Nikko at Beverly Hills Portable telephone system throughout hotel	Installed a portable telephone system throughout the hotel. Phones can be used for any outgoing or incoming calls, but work only within the confines of the hotel.	A portable system was chosen over a cellular one because of its greater reliability. It was installed at night to minimize inconvenience to guests.	Increased telephone use and revenues and increased customer satisfaction
IT to improve efficiency and guest service			
IMPAC Hotel Group A lobby kiosk touch-screen guest tracking system	Each lobby contains a kiosk with a touch-screen monitor on which guests can respond to a survey about their stay. Data re downloaded and made available to the property manager the next morning.	System was developed in-house in conjunction with a third-party software company. Kiosks were placed in each property and now incorporate a work station connected to a mainframe computer in Atlanta via T-1 phone lines	Improved maintenance and productivity and improved overall quality and image of property
Radisson Worldwide Reward Program for travel agents	Developed "Look to Book" program, which rewards travel agents with points that can be redeemed for travel or gifts based on the number of reservations they book online with Radisson.	The goal was to develop a seamless, paperless loyalty-point program for travel agents that would instantly recognize and award each travel agent's Radisson booking. After technical and programming work were completed, a training and support system was developed to instruct agents on its benefits and how to participate.	Increased travel agent participation and profitability

			Continued...
IT to improve efficiency of internal operations			
Courtyard by Marriott Intranet Information Sharing	Developed intranet information resource that organises information into a single, easy-to-use property resource, using computer and electronic technology to replace manuals and other printed information.	Twenty regional technology leaders train Courtyard managers and key people on its Intranet system, which provides brand standards, answers operating questions, assists users in expediting routine tasks and provides timely and accurate information to solve hotel problems. A minimum of two computer stations is available in each hotel to allow immediate access to the system.	Increased productivity; reduced labour costs; and eliminated production and distribution costs of standard operating-procedure pages and binders
Carlson Hospitality Worldwide World-wide Reservation System	Created the most extensive, efficient and productive reservation system existing today.	Built from scratch its own reservation system that is designed to provide more-specific information on each property and more capabilities than the airlines' inflexible CRS mainframe systems were providing, while retaining the ability to connect with the CRSs. Developed seamless interface to GDS years before other companies.	Highest contributor at the lowest cost
The Barbizon Hotel and Empire hotel NY	Software eliminates logbooks and standardizes record keeping	Increased productivity and reduced labour costs; improved response time to vendors, guests and employees and decreased storage costs	Increased repeat-guests rate and quality of service and productivity; eliminated paperwork; and increased ability to analyse trouble spots
Inter-Continental Hotels & Resorts Building a global marketing database	Created global strategic-marketing database containing detailed and extensive guest histories and consumption patterns for guest stays worldwide.	Jointly developed by the rooms department and the information technology department to meet the marketing department needs. After developing the technology, standards and training were implemented to ensure standardised coding worldwide. Data is regularly e-mailed from all worldwide locations for uploading.	More effective targeted mailings; increased ability to measure advertising effectiveness; increased guest loyalty program participation; and altered decision making of senior management
Kimpton Group Hotels and Restaurants and Outrigger Hotels and Resorts Private label reservation system to encourage upselling	Private label reservation system has cross-selling capability that serves to contribute to improved occupancies and rates. System provides different quotes for specific dates and includes an on-line incentive to encourage upselling the customer	When a reservation agent selects a hotel and room type for a specific date, the system provides three initial quotes, each showing an on-line incentive-point value. The system also provides data for any rate and room-type combination available, so the agent can sell the customer without having to enter multiple requests.	Increased ADR and profits; reduced labour costs; and increased attention to guests
Marriott International Aligning Information Technology with corporate strategy	Developed process to ensure that future systems and technologies support the corporate business strategy. The alignment is guided by a plan for a series of projects that must be executed to deliver the appropriate capabilities.	The plan covers three phases: baseline assessment, strategy development and plan formulation. Each phase examines the use of information technology throughout the organisation.	Increased operational efficiency; reduced costs; and eliminated guesswork. Increased revenues; improved profile of guests; and identified weak-occupancy periods
Marriott International Revenue Management Systems for Revenue Enhancement	Developed revenue-management system that isolates the different market segments that use Marriott properties and provides a comprehensive understanding of those segments' reservations behaviour, price sensitivity and stay patterns.	Current system evolved from earlier yield management systems. Fully integrated with the reservation system, the revenue management system creates arrival – demand forecasts and provides inventory restriction recommendations. It also provides overbooking recommendations for each property.	Increased operational efficiency; reduced costs; and eliminated guesswork. Increased revenues; improved profile of guests and identified weak-occupancy periods
Omni Hotels Integrated property – management and Revenue management system	Integrated a company-wide property management system in its reservation system to produce a fully integrated, highly efficient reservation system that includes yield management capabilities.	The development team collected information from all critical property managers to determine what was needed in the system. Based on these data, a third party developed a user-friendly Windows-based program that expedited training on the new system.	Increased revenues; increased service levels to guests and reduced overbookings
Promus Hotels On-line integrated payroll-benefit accounting system	Developed a computerised, integrated payroll and benefit accounting system that is accessible online. Using a customised Windows program, the system displays the various benefit options available to an employee. After employee selections are made, the choices are automatically forwarded to corporate headquarters.	The system was developed by the technology department with input provided by human-resources managers, general managers and the corporate human resources department. Memos, manuals, instructions and technological support were provided to the hotels as the system was implemented. The system replaced manuals and forms.	Reduction in errors in selection of benefits and increased speed of response and productivity

Source: Siguaw and Enz (1999)

6.3.1.3 The metrics measuring IT

A major and often cited issue for criticism of previous studies on IT productivity has been the way they have defined and measured the independent variable, i.e. IT. Indeed, a constant criticism of traditional IT metrics is found in the literature, (Graeser et al, 1998; Robson, 1997, Strassmann, 1990). Strassmann (1990) argued that the majority of techniques evaluating the impact of IT suffers from a disproportionate emphasis on the costs of computer equipment. Indeed, the majority of studies have operationalised this variable as some measure of total IS expenditures either by organisation or by industry (e.g. Banker and Kauffman, 1988; Panko, 1991; Roach, Katz, 1988; Harris and Katz, 1988; Datamation, 1987). Other researchers have used somewhat different types of this concept such as MIS dollars per office worker (Panko, 1982), amount invested in different types of systems (Weill, 1990), or a number of *"substitutes for investment"* such as computer ownership, number of applications (Cron and Sobol, 1983; Alpar and Kim, 1990), number of personal computers (Mahmood and Mann, 1991), amount spent on computer training (Mahmood and Mann, 1991) and type of software capabilities (Cron and Sobol, 1983). Figure 6.3.1.3.a summarises a great variety of financial or other equivalent metrics that had been used for measuring IT investments.

Figure 6.3.1.3.a Financial metrics and substitutes metrics measuring IT investments

- **Measures of IT actual /budgeted investments (in monetary terms)**
  1. salaries and benefits
  2. hardware
  3. software
  4. MIS annual expenditures
  5. total value of IT assets, including hardware and software
  6. value for estimated annual IT budget
  7. IT budget spent on IT staff
  8. IT budget spent on IT staff training
- **Measures of IT investment in numbers**
  1. number of standard applications (areas) computerised
  2. number of IT employees
  3. number of personal computers and terminals per company
- **Measures of IT investments as percentage of other measures**
  1. IT expense as a percentage of total operating expenses
  2. IT expenses as a percentage of sales
  3. IT budget as a percentage of sales
  4. Percentage of hardware expenditures on personnel costs
  5. Percentage of IT budget spent on IT staff training
  6. value of firm IT as a percentage of sales
  7. value of firm IT as a percentage of revenue
  8. percentage of total PCs and terminals per employee.
- **IT investment measures (percentage of industry standards/norms)**
  1. percent of total value of IT assets in total assets
  2. percent of annual IT budget in total budget
  3. percent of annual IT expenditures in total expenditures
  4. percent of hardware expenditure
  5. percent of software expenditure
  6. percent of personnel expenditure
  7. percent of training expenditure
  8. number of standard applications (areas) computerised per employee
  9. number of IT employees per employee
  10. number of personal computers and terminals per employee

The purpose of these measures is to determine how much IT a company is using and then correlate it with company performance. The reason that MIS budgets have been the most frequently used measure of computerisation is that these figures are readily available as well as being reasonably objective. However, crucial concerns and critiques have been advocated regarding the reliability and validity of these metrics.

One issue regarding the measurement of IT investment in terms of invested pounds is whether IT expenditures are captured as a total unit or whether they separate hardware and software, personnel and other expenses. The assumption behind the latter is that investment in different types of IT might affect performance differently (e.g. Lucas's research, 1999, revealing different return of different IT applications). In this vein, a number of studies have divided IS budgets into spending for different types of computer applications (Cron and Sobol, 1983) and looked at divisions of MIS spending on software, hardware, personnel and other components. For example, in his study of the insurance industry, Bender (1986) concluded that there is an optimal level of investment in IT, as investment in MIS people, hardware and environment were significantly related to financial performance, while investments in software were not. Lockwood and Sobol (1989) also reported on IS expenditure on such items as personnel, hardware, software, communication and miscellaneous. Each of these categories was then further subdivided into 6-8 categories. However, although this article subdivided budgets, it did not, relate these different subdivided budget spending expectations to the financial expectations for the firm or the economy.

However, the arguments that different types of investments are independent and that a proposed IT innovation fits into only one category are not easily sustained. On the contrary, it is quite possible that an IT investment will fit more than one category. In particular, Lucas (1999, p. 19) argued that *"long-lived application of technology moves from one investment type to another as it matures and as the organisation faces the decision to make additional investments in the application".* Lucas' (1999) research findings also revealed that the total impact of IT investments is more than the sum of their individual contributions, because applications of IT interact with one another, creating new benefits and opportunities. In other words, the cumulative impact of investments in IT exceeds the sum of their individual contributions, but studies trying to investigate a link between different IT projects and performance ignore such synergy effects. Moreover, when the synergetic effects of many different IT applications in different organisational areas are considered one can see that only organisation-level productivity analysis and measurement can truly capture the full impact of IT on a business.

Moreover, distinction of investments in different types of IT resources has been argued to have the following shortcomings as well. First, software costs are usually not tracked and treated as on-going expenses rather than IT investments, which makes collection of such data difficult. Second, Strassmann (1985) pointed out that in the realm of IT, most estimates are made of the cost of equipment, when actually only 20% of the cost of IT introduction is attributable to equipment and one of the real costs is the "people", but this is treated as an ongoing expense. So, financial metrics of IT are not considered as reliable and representative metrics of IT resources as *"public sector accounting and fiscal appropriation practices guarantee that the full information-technology cost will remain unknown"* (Strassmann, 1985, p.84).

Despite the difficulties and problems created because of the way businesses measure and classify IT expenditures (e.g. Strassmann, 1985), metrics looking at IT expenditure as a total as well as as a break down of IT budgets in different IT resources also suffer from fluctuations over time. Indeed, not only overall budgets can differ between years but also expenditures on each IT resource (e.g. software, hardware, personnel etc) can change every year. At a given time, differences in investments amongst different IT resources across companies may be due to differences in the accumulated IT resources that companies have, e.g. companies with heavy IT infrastructure will invest less in hardware and more in software, while companies with low IT infrastructure would need to invest in both resources. Thus, because of these differences IT investment budgets are not considered a reliable metric for comparing IT resources across businesses.

In order to overcome comparison problems due to changing or different IT budgets and expenditures, a literature has emerged that breaks data processing budgets into software and hardware components and attempts to predict the proportions of these components of data processing budget over time. Early studies of MIS spending predicted an increase in the relative size of software budget components over time and a decline in the proportion of hardware (Boehm, 1973), which was based on the fact that hardware costs have decreased dramatically over the years due to technological improvements. Frank (1983), based on annual budget surveys over a ten-year period (1971-1981), found constant budget shares allocated to hardware, staff, overhead, software and services even as total computer expenditures have increased.

Gurbaxani and Mendelsohn (1987) developed a theoretical framework to explain these phenomena. They suggested that while software and hardware are complementary inputs (i.e. an investment in one requires an appropriate investment in the other to achieve the desired benefits), they can also be substitutable and hence, varying ratios of the two can be used to produce any given output. Their model also showed that there is a sound theoretical basis explaining the constancy of the percent of hardware and software shares in the total IT budget. Thus, programmer productivity can be enhanced by using hardware more extensively. For example, higher-level programming languages allow for significant reduction in software development effort while requiring higher hardware investment. As software becomes relatively more expensive, users can decrease its cost by utilising more hardware.

However, apart from the fact that such models are difficult to apply in order to predict IT expenditures, Willcocks at al (1998) also argued that firms do not always act rationally and according to models. After proposing a model of ICT investment cycles/eras, she also went on to argue that metrics representing IT expenditure are not reliable indicators of IT resources because they do not count for the different IT economics in the different eras.

For example, nowadays, with the advent of the Internet and more widespread adoption of client and server (network) IT infrastructure, software is increasingly being replaced by hardware. For example, Application Service Providers (ASP) provide software over the Internet on a pay per use basis. This means a change in the IT expenditure structure, less IT sunk costs and more variable IT expenses, less maintenance and service costs. For example, Fidelio, the biggest IT supplier of Property Management Systems (PMS) in the hotel sector, allows hotels to access software and applications through the Internet. This simply means that hotels do not need to invest in any IT equipment apart from computers with an Internet connection. In this vein, the IT expenditure metrics for hotels running their PMS applications over the Internet would have been lower than those of hotels with property-located IT investment, but both types of hotels would have the same IT functionality. Thus, IT expenditures are an unreliable metric of IT resources. Another example is the use of network technologies by big hotel chains for centralising their data processing (e.g. payroll, reservations, back office, customer databases) and integrating their corporate systems with their hotel properties' systems through Intranet or Wide Area Network infrastructures. This practice lessens software applications at the unit level and increases IT infrastructure, while the network infrastructure also reduces software and maintenance expenses within a firm. Thus, use of IT expenditures for comparing IT resources across hotels would have been unreliable.

On the other hand, Willcocks et al (1998) argued that in the content era the most significant factor for boosting firm performance is the collection and use of data and information (e.g. customer databases). As chapter five stressed, information is nowadays being considered as the fourth resource of businesses along with the three traditional ones, i.e. labour, land and capital, and is one of the most important IT components that can significantly contribute to productivity. However, IT expenditure metrics do not incorporate the value of information, which in turn makes their validity questionable. Strassmann (1998) also claimed that information and knowledge constitute significant components in the costs of products/goods but they are not included in the traditional Cobb Douglas production functions. However, a way of measuring the value of information has still to be found (Parker et al, 1988).

However, by concentrating on IT expenses per each IT resource the original question of *"what is the relationship between IT use and organisational performance"* is diverted to *"what is the relationship between investments amongst different IT resources and organisational performance"*, which is more related with IT decision-making per se (i.e. selecting the right IT application) rather than business management decision-making (i.e. assess whether IT has a business value, e.g. boost productivity).

Moreover, the cost of IT on its own does not reflect satisfactorily the different IT resources between organisations not only because IT costs always decrease (i.e. a pound of IT now can buy more IT power in the future), but also because the value of IT significantly depends on how it is being used. In fact, a computer per se is not worth more that its value quoted in an auction. In this vein, the major caveat of metrics measuring IT investments in financial costs is considered to be the fact that they give limited insight as well as no relationships between IT and productivity. This is because IT in itself is not a determinant of organisational or individual outcomes but rather an enabler whose effects are dependent on how it is used (Barley, 1986; Markus and Robey, 1988; Pinsonneault and Kraemer, 1993; Robey and Sahay, 1996). In other words, it is more important how IT is being used rather than how much is being spent on IT that actually affects productivity. Because of this, it is generally agreed that metrics based on financial measures are a very poor surrogate for assessing a firm's IT intensiveness as well as for helping managers on how much and on which IT to invest.

Indeed, in his studies, Strassman (1990, 1997 and 1998) established convincingly that the size of IT spending bears no relationship to subsequent IT effectiveness and concluded that it does not matter how much you spend on IT but how you use IT. For example, after comparing data from 468 corporations, Strassmann (1997, p.35) concluded that high performing firms do not allocate more money to IT than low performing firms. This randomness did not change with other measures of profitability, such as return on assets, return on net investment of economic value added divided by equity. Similarly, no measure of technology intensity, such as IT spending per revenue dollar or IT spending per asset value, made any difference. Strassmann (1997) concluded that this proved that it is not computers, but how a firm manages, along with everything else, that makes the difference.

McKeen and Smith (1993) also pointed out that IT budgets have been used almost exclusively as a measure of degree of computerization but this has led to the neglect of an important facet of IT, i.e. its deployment. This may also explain the equivocal results of studies linking heavy IT investment to either high or low performance (Bender, 1986; Cron and Sobol, 1983; Harris and Katz, 1988, Harris and Katz, 1988). Ahituv (1989, p. 315) also argued that "*the business value of IT investments cannot be separated from the value of the applications that exploit IT*" and so IT usage is a better measurement for linking IT investments with organisational performance.

Strassmann (1998) also argued that IT as a percentage of revenue has also been a very favourite measure for evaluating benefits from computer spending (i.e. through IT expenditures to revenue ratio analysis). However, a higher ratio of IT to revenue does not prove higher effectiveness in the use of computers. More spending is not a sign of technological progress, while spending money on IT is not dependent on gross revenues. Willcocks (1992) also argued that metrics of IT costs, such as IT expenditure as a percentage of turnover (which can then be compared to an industry average) or what a competitor is spending, are of very limited value because they cannot identify and focus investment on where IT adds value to the organisation. According to Strassmann (1998) the preferred way of making judgements about IT spending is to examine key business processes, such as customer care, goods production, post-sale support and product innovation.

Berger et al (1991) also showed that when managers try to articulate the value of IT on their enterprise, they traditionally focus on IT inputs rather than outputs. Indeed, managers were found to be more concerned with financial measures (e.g. total IT budget, hardware budget, costs overruns or number of PCs per employee etc) and the same pattern has been followed with the majority of previous studies investigating the relationship between IT and business performance. As, financial metrics regarding IT were correlated to a range of performance measures, this approach also reflected an attempt to judge the performance of IT – as a resource- in terms of the performance of IS, as an organisation. In this vein, managers have been heavily concerned with whether a new system is delivered on time, within budget and in accordance with specifications. However, Strassmann (1990) argued that this type of measurement recognises only part of a company's IT activity ignoring the huge range of other IT applications, while Berger et al (1988, p.5) advocated that "*attention has to be given to the value of IT outputs*" and critiqued established input-oriented measurements highlighting the need to give particular attention to the way IT resources are being used.

Previous arguments highlight the need to distinguish the impact of IT performance from studies investigating the IT productivity impact. This is reflected in several studies. For example, in assessing the relationship between IT and business performance, the McKinsey study (in Kempis and Ringbeck, 1998) made a distinction between the impact of IT efficiency and of IT effectiveness on business performance. The former concepts relate to the traditional financial measurement of IT as an organisation (e.g. overall cost of IT project implementation relative to budget), while the latter reflects the way IT applications have been diffused within organisations changing, improving and enhancing business processes and individual tasks. Findings showed that although IT efficiency was crucial for achieving business performance, it was IT effectiveness that had the greater impact on business performance.

In their review of the literature, Weill (1988) and Kauffman and Weill (1989) argued that a crucial mediating factor of the relationship between IT and performance that they named "IT conversion effectiveness" had been neglected. This concept refers to the effectiveness with which investments in IT are converted into useful outputs and so, it can be considered as compatible with measures of IT performance (e.g. ability to implement IT projects on time and budget). Weill (1988) argued that conversion effectiveness might explain how one company could invest heavily in a state-of-the-art system which is not especially useful and receive little or no benefit from its investment (e.g. Strassmann, 1985), while another could invest the same amount in another way and see the investment payoff handsomely.

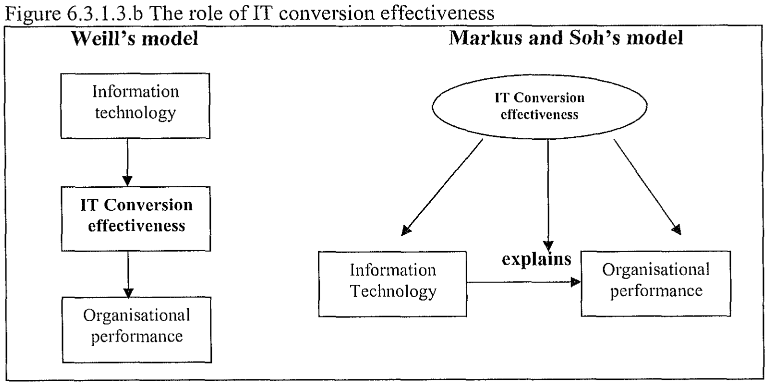
In the same vein, Lucas (1999) adopted the concept of the garbage can model in order to depict the relationship between IT investments and business value. In his model, he argued that factors influencing the conversion of IT investment into a successful project can come from the actors of the system (e.g. users, management, consultants etc), the tangible components (e.g. databases, software) and the intangible components (e.g. business strategy, users needs and ideas etc). A non-ending list of such factors included: size and scope of the project; amount of unknown technology involved; project management; support and encouragement of managers; sponsorship; the urgency of the problem; norms in the organisation; user commitment and involvement; technical development environment; quality of the IT staff; strength of the project team; level of expertise of participants; type of technology employed; type of application; nature of packaged software included; use of external consultants; degree of understanding between users and developers; presence of a project champion; senior management involvement; amount of organisational change required; vested interests; users' views of the quality of the system.

Markus and Soh (1993) further embellished the concept of conversion effectiveness suggesting that there are two groups of moderating factors, which determine whether or not the impact of IT is realised:

1. Structural factors: (beyond the immediate control of the management) that create differences among firms in their ability to derive benefits from IT spending (e.g. firm size, type of industry, competitive position within the industry, general or specific-industry conditions);
2. Internal managerial processes; (under the direct control of management) including formulating IT strategy, selecting an appropriate organisational structure for executing IT strategy, developing the right IT applications and managing the IT application development effectively).

Markus and Soh (1993) favoured a much more inclusive view of conversion effectiveness by suggesting that conversion effectiveness is evident when there is a strong positive relationship between IT and firm performance, and when the CEO attributes firm performance to IT. In other words, according to Markus and Soh conversion effectiveness is not a mediating factor of the IT-business performance relationship (and so there is no reason for measuring conversion effectiveness per se), but rather it helps in understanding the fit between the pattern of IT assets, factors that affect the firm's ability to receive benefits from these assets and firm performance. That is to say that IT conversion effectiveness can significantly determine IT assets, business performance and the ability to translate IT resources to business benefits. The two ways of conceptualising this concept are illustrated in Figure 6.3.1.3.b.

Figure 6.3.1.3.b The role of IT conversion effectiveness



Overall, the measurement of IT by focusing on IS performance metrics is important, but it has been considered as an inappropriate and inadequate metric for measuring the business value of IT. In order to accomplish the latter, how the IT resources are being used organisation wide should also be considered. In particularly, Berger et al (1991, p. 72) argued that *"the organisation's business objectives should be treated as the objects of measurement in the IT measurement process"*, meaning that IT measurement should reflect and identify IT applications that support and/or enhance the organisational objectives and practices. Berger et al (1991) called this approach *"enterprise-based methodology"*, because it explicitly focuses on IT's contributions to an enterprise's overall business plan. They also argued that the categorisation of IT investments according to their business impact also enables management to select appropriate measurements that can function both as IT investment and performance criteria. To that end, existing business measures currently used by companies should be used, because they are simply stated and easily understood, while in terms of IT metrics, they suggested categorising IT based on their business activity by considering IT applications areas and major systems rather than programs or subsystems.

These arguments are compatible with Strassmann's (1988) research findings that overall highlighted the need to avoid relating IT expenses to business performance measurements and increasingly to focus on IT applications. Analytically, based on the empirical evidence of his studies, Strassmann (1988, p. 25) reported:

- *"the level of information technology expense does not directly relate to management productivity. Business using large amounts of information technology do not deliver results superior to firms using lesser amounts of information technology;*
- *companies that are subject to fundamental strategic hardships such as low market share and an inferior product quality cannot remedy these conditions principally through computer aided management;*
- *computers will not make a badly managed business better. The expenses for computerisation and the increased rigidity in computer managed procedures are likely to accelerate the decline of incompetent management.*
- *computers may produce information-processing costs;*
- *companies most likely to benefit from computer investments are those that have simplified their management, focused on improved quality, reduced their assets and introduced innovative ways of delivering value-added to customers. Such companies also obtain additional benefits from reduced administrative costs;*
- *strategically sound organisations benefit from computers. They have more than twice the amount of computer expense, per capita, than companies with a low level of productivity".*

Arguments supporting and directing research that investigates the IT productivity impact towards the identification and measurement of IT deployment rather than of IT performance and expenditure also come from the operations literature. In operational theory, IT is regarded as the transforming assets of the business processes. There is a rich history of literature demonstrating the importance of processes in analysing firm performance (e.g. Chase, 1981 and 1983; Levitt, 1972; Roth and van der Velde, 1991; Roth and Jackson, 1995; Shostack, 1987). In addition, Roth and Jackson (1995) provided clear evidence that process capability and execution are major drivers of performance due to their impact on customer satisfaction and service quality. However, the measurement of IT in terms of expenses provide little or no insight of the IT contribution in the transformation process. Frei (1996) found in his study that there is no correlation between the money spent on technology and its capabilities. It is so important to realise that the technology input is not the cost of the machines, but rather the capability of the machines. Thus, in using DEA for measuring banks' efficiency, Frei and Harker (1996) used IT capabilities instead of IT costs as process inputs claiming that there are often orders of magnitude in the amount spent for similar IT capabilities. They used the concept of IT functionality as a measurement of IT capabilities in order to separate out the performance of the IT procurement/investment process from the performance of the service delivery process. Overall, it was asserted and validated that DMUs using less technology functionality for similar levels of outputs are more efficient.

The criticism on the use of expenditure metrics measuring the IT intensity of the firms is also shared by researchers (e.g. Barney, 1986; Conner, 1991; Rumelt, 1984; Schulze, 1992) who adopted a resource-based view (RBV) in order to investigate the effects of IT on firm performance. The RBV links organisation performance to resources and skills that are firm-specific, rare and difficult to imitate or substitute. In applying a RBV to IT, researchers argued that since investments in IT are easily duplicated by competitors, investments per se cannot provide any sustained advantage. Rather it is how firms leverage their investments to create unique IT resources and skills that determine a firm's overall effectiveness (Clemons, 1986, 1991; Clemons and Row, 1991). Thus, although there might be similarities in IT investments across firms, IT resources and skills tend to be heterogeneously distributed, which then leads to different patterns of IT use and effectiveness. In short, a RBV perspective would illustrate and place IT resources and skills as the connection link between IT and business performance.

An effort worthy mentioned in the field of the RBV that has significantly contributed to the growing body of literature on IT and performance is that of Bharadwaj (2000). After reviewing and building on the RBV theory, he developed links that provided a theoretical framework for understanding how IT capability leads to business performance. A firm's IT capability was defined as *"its ability to mobilise and deploy IT-based resources in combination or copresent with other resources and capabilities"* (Bharadwaj, 2000, p. 171). This is compatible with the long term arguments of sceptics of the IT's direct value on firm performance supporting that firms benefit from IT only when IT is embedded in the organisational structure in a way that produces valuable, sustainable resource complementarity (Clemons, 1986; Clemons and Row, 1991). Specifically, the IT-based resources whose interactions can create an IT capability were classified under three categories namely, physical IT infrastructure (measured as reach and range, Keen, 1991), the human IT resources comprising both technical and managerial skills and intangible IT-enabled resources such as information/knowledge assets, customer orientation and synergy. The IT infrastructure provides the platform to launch innovative IT applications faster than the competitor, human resources enable firms to conceive and implement such applications faster than competitors while IT-enabled intangibles enable firms to leverage or exploit pre-existing organisational intangibles, e.g. customer orientation.

Bharadwaj (2000, p. 186) also tested his theoretical framework and provided empirical evidence showing *"a positive and significant relationship"* between superior IT capability and superior business performance, measured by a variety of profit and cost-based metrics. Results of this study were regarded as an explanation for the IT productivity paradox. As Bharadwaj (2000) claimed, previous findings showing a non or a negative correlation between IT investments and firm profitability, may be due to the fact that despite high IT investments, not all firms may have completely understood and exploited the nature of the IT resources in order to create successful IT capabilities. However, Bharadwaj's (2000) empirical findings are subject to the objectivity of the IT capability rankings of the Information World data that he used in order to distinguish between businesses with different IT capabilities. The use of ranking provided by the Information World Data also suggests that his research did not also illustrate the underlying mechanisms through which business performance is achieved. Because of these, Bharadwaj (2000) suggested that further research is required that will focus on developing better metrics for evaluating IT resources and will specifically identify how IT capability leads to firm performance.

On the other hand, the theoretical and empirical test of the RBV reinforces arguments from the operations management theory that identify two reasons for performance differences: a) the impact of the asset frontier (i.e. the impact of the IT resources, infrastructure); and b) the impact of the operational frontier (i.e. the impact of IT use, e.g. IT intagibles). So, the major contribution of the RBV is its explicit recognition of the value and performance impact of intangible organisational resources (such as product quality and customisation, customer service, market orientation, knowledge assets, organisational memory, synergy, know-how, Quinn and Baily, 1994) that the exploitation of the information element of IT can have as chapter five argued. Indeed, Brynjolfsson and Hitt's (1997) survey revealed that highly effective IT users tend to pay greater attention to the intangible benefits of IT such as improved customer service, enhanced product quality and increased market responsiveness.

The need to consider and measure IT assets such as information, synergy and co-operation fostered by IT integration and networks, product customisation etc is also highlighted in Willcock et al's (1998) arguments. Willcocks et al (1998) argued that assumptions and theories trying to explain IT productivity had been time-bound and limiting because they failed to take into consideration the technological shifts in terms of ICT capabilities and their economic implications. Willcocks at al (1998) developed a model of ICT investment eras and argued that a more detailed understanding of the differing economics underlying the various types and capabilities of ICT will have profound implications on how IT investments are made, assessed and monitored.

Teo et al (2000) also argued that the understanding of the relationship between different uses of IT assets would lead to more informed IT investment decisions, more realistic expectations of what IT investment can achieve, more effective evaluation of IT performance and better utilisation of IT as a tool for strategic management. Teo et al (2000, p. 270) claimed that *"assumption of IT homogeneity reflected in the use of aggregate IT expenditure metrics could create misleading results on the impact of IT since different systems exist for different management objectives"*. Thus, a more sound approach to disentangle the IT productivity paradox is to explain how the different ICT applications and use of their capabilities can lead to productivity benefits. In this vein, Sigala et al (2001c) illustrated how the different ICT investment eras affect the application of yield management and argued that hotels with more sophisticated configuration and use of their computerised yield management systems can seize greater strategic and operational benefits.

Other authors within the hospitality and tourism literature have also advocated the need to consider and measure the use and level of deployment of IT assets when investigating the IT productivity impact. Specifically, several studies (e.g. Rai et al, 1997; Baker and Sussmann; 1999) confirmed that links between productivity and IT should be considered in the light of disaggregated IT investment, because the latter considers and reflects different IT applications that may have different impacts. Several other authors (e.g. Werthner and Klein, 1999; Gretzel and Fesenmaier, 2001) have also argued that the relationship between IT and business performance is not a direct one, but IT creates business value when it is being used. In this vein, the ways in which IT are being applied and the level of their exploitation should be considered. For example, after recognising the importance of information and its use, Werthner and Klein (1999) claimed that an assessment of the IT impact should make a distinction between three categories of IT namely IT infrastructure, IT services and applications and information. IT infrastructure was defined as a generic functionality that does not reflect a specific type of application, whose value can be conceptualised as the value of a traffic infrastructure (e.g. Malone and Rockart, 1991; Bakos, 1987).

Arguments for the inappropriateness of financial metrics for investigating the IT productivity impact have also risen in the IT and Information Management literature. Dos Santos and Sussman (2000) claimed that expenditure figures indicate how much companies are "paying" and not necessarily how much they are "using". Thus, McKeen and Smith (in Banker et al, 1993, p. 420) claimed that using MIS pounds almost exclusively as a measure of degree of computerisation has somewhat obscured an important research question: i.e. the focal question should be: *"What is the impact of IT on a firm's performance? Not "What is the impact of investment in IT on a firm's performance?"*. Weill and Olson (1989) also advocated that the focus on investment dollars has removed from consideration an important facet of information technology, i.e. its effectiveness. Kauffman and Weill (1989) pointed out that researchers have neglected to consider IT effectiveness explicitly in their models (Figure 6.3.1.3.c). However, the latter was argued as an important moderating variable in the relationship between the investment of IT and organisational performance that helps to explain how it is possible that a company could invest heavily in a state-of-the art system which is not especially useful and receive little or no benefit from its investment, while another could invest the same amount in another way and see the investment payoff handsomely.

Figure 6.3.1.3.c Relationship of IT investment and Organisational performance

IT investment → **IT effectiveness** → **Organisational performance**

Source: McKeen and Smith (in Banker et al, 1993)

Several authors have tried to operationalise and measure IT effectiveness. In his literature review, Miller (1989) identified four measurements of IT effectiveness namely economic benefits, process outcomes (e.g. cost benefit analysis), IT usage and user perceptions (i.e. user attitudes to IT or user satisfaction). Miller (1989) and Miller and Doyle (1987) advocated that in most of these studies the concept of IT effectiveness is also used as the dependent variable in the IT - organisational performance relationship.

However, although user attitudes and user satisfaction have become a surrogate measure for IT effectiveness, Banker et al (1993) claimed that the construct is poorly developed. Proponents of user attitudes argued that if users feel positively towards a system, it must be helping them to do their job better and so, performance must be improved. Measurement of effectiveness is based on surveys of users' beliefs and attitudes towards IT. Effectiveness is usually then related to various project, system and organisation characteristics (e.g. Srinivasan, 1985) in an attempt to determine which characteristics relate to positive user attitudes. However, recent research suggests that the relationship between attitudes and IT effectiveness may not be quite as straightforward as this literature supposes. For example, Smith (1989) suggested that there are certain organisational and social variables that play an important part in users' attitudes towards IT. Moreover as Kling (1980), Markus, (1987), Smith and McKeen (1992) found other organisational implications of certain systems (e.g. loss of power, politics) can strongly affect user attitudes as well.

In examining many measurements of IT effectiveness, Trice and Treacy (1986) pointed out that they all involve measuring utilisation of a system. Hence, they concluded that the system utilisation must be an intervening variable between IT investment and organisational performance since IT cannot have an impact on performance unless it is used in some way. In this vein, it was argued that IT utilisation should replace IT effectiveness in the IT – organisational performance relationship (Figure 6.3.1.3.d). Moreover, Trice and Treacy (1986) warned that although the linkages between system utilisation and organisational performance may be complex, they concluded that it is impossible to trace a clean theoretical path between IT and performance without including utilisation.

Figure 6.3.1.3.d Relationship of IT investment and Organisational performance

IT investment ⟶ **IT utilisation** ⟶ **Organisational performance**

Source: Trice and Treacy (1986)

The arguments against utilisation as a measure of IT effectiveness pointed out that IT can be used extensively to make bad decisions (Ginzberg, 1978, Srinivasan, 1985). In particularly, Ginzberg (1978) noted that in these circumstances utilisation would be a poor measure of IT effectiveness, while if IT use is mandatory, then the relationship between utilisation and effectiveness is somewhat tenuous. However, although these objections to utilisation may be important in longitudinal studies, it is argued that they are less substantive in cross-sectional research (e.g. Dasgupta et al, 1999; Mitra and Chaya 1996) whereby firms making effective use of IT would stand out.

The arguments in favour of utilisation as a measure of system effectiveness assume that if a system is effective then the people will use it; otherwise, it will not be used. More use is taken if users think the system is beneficial (Ein-dor, Segev and Steinfield, 1982). As firms installs more and more IT, total utilisation will naturally increase. If the new systems installed are useful to the firm, overall utilisation of the firm will continue to increase. But if the systems are not beneficial this too will be reflected in slower or nil rates of increased use.

Dickson and Wetherbe (1985) identified three different types of IT that illustrate how IT usage can affect performance. These are as follows:

- *Strategic IT*, which provides useful products or services will be used more than those which are less useful. Thus, there should be a positive relationship between increased usage and increased revenues;
- *Informational IT*, which provides worthwhile information will be used to prevent problems or identify opportunities to increase revenues or reduce costs. If worthwhile information is not provided, these applications will cease to be used;
- *Transactional IT*, which is used to reduce costs or limit cost increases, should be closely related to performance to the extent that it is used instead of human labour. For example, if an organisation can increase its revenues by 50% while containing its labour force increase to 5% by using IT, it is getting a significant benefit. Thus, the more effective transactional IT is used, the better the business revenue per capita ratio will be.

Trice and Treacy (1986) argued that another facet of understanding how utilisation links IT to organisational performance is *the degree to which IT is used in an organisation*, which is a key assumption behind studies that use MIS budgets as indicators of IT. In short, this was explained as follows. Money must be invested in IT in order to gain the potential benefits of increased revenues or reduced costs. Theoretically, if more money is invested, greater benefits will accrue. If IT does not provide these benefits, it will not be used and organisational performance will be neutrally or negatively affected. On the other hand, if IT is being used effectively, then more money invested in IT will certainly relate to a greater improvement in organisational performance. Therefore, the degree to which a firm is computerised should affect the strength of the relationship between usage and performance. Indeed, there may be a *"threshold effect"* indicating that significant benefits from IT are not realised until a certain level of investment in IT is reached (Weill, 1990). Thus, overall, because utilisation is a measure of both the effectiveness of IT in an organisation and the degree to which is used, it is believed to be a measure of IT effectiveness superior to subjective variables such as user attitudes or satisfaction (Trice and Treacy, 1986).

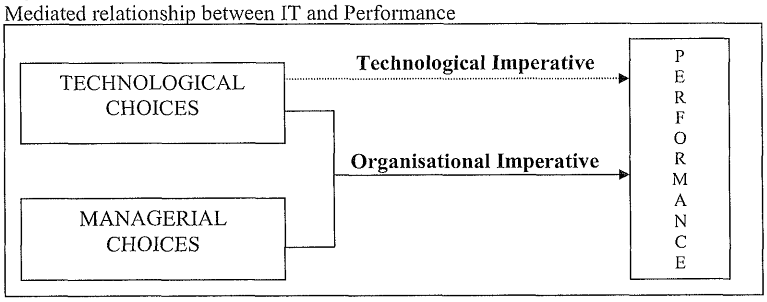
In examining how researchers have operationalised the IT utilisation variable, Trice and Treacy (1986) found that most studies have used subjective measures such as reported use, frequency of use, or plans to use a system, while very few studies have used unobtrusive and objective measures such as machine usage statistics. They however commented that the lack of standardised measures lead to considerable error. Mckeen and Smith (in Broadent et al, 1993, p. 434) also reported that in their research total IT usage hours showed a stronger and more significant relationship with business revenues than total IS budget expenditures and commented that that was anticipated because IT effectiveness is a crucial mediating factor in the relationship between IT investment and organisational performance and because the number of IS dollars spent does not always translate into effective IT. However, they highlighted that the limitations to their measurement of IT effectiveness (i.e. computers' hours) was that it did not make the distinction between the use of different IT applications. Thus, although the measurement of IT effectiveness in terms of total hours of IT usage allows standardisation for cross company comparisons, it still is a composite of IT usage that does not distinguish between different types of IT applications.

Indeed, studies that have measured the different use of IT as well as the different IT applications and configurations provide more useful and reliable results on the IT productivity paradox. For example, Weill (1988) tried to address that issue by distinguishing IT investments in three categories namely transactional (aiming at cutting costs), strategic (aiming to provide competitive advantage with respect to the firm's competitors) and informational (referring to information infrastructure to facilitate information access and communications). However, like Willcocks et al (1998), Weill (1990) also recognised that the three types of IT will not be sufficient over the long term, and new categories will be necessary because of the tremendous evolution in IT capabilities and applications. Thus, in their study, Teo et al (2000) included a fourth type of IT investment, the threshold IT, referring to investments made just to compete as they are often made to imitate competitors' technology level and regardless of whether they have a positive productivity impact. In evaluating the impact of diffusion and level of IT usage on marketing, Brady et al (1999) adopted a similar approach. Specifically, they categorised ICT applications into three categories namely automational, informational and transformational and after collecting data from 204 marketing managers in Ireland, their findings provided evidence that firms using IT in different modes experienced different benefits. Specifically, firms with more transformational ICT applications were found to have more benefits and so, they concluded that firms should reconsider the ways they use IT in order to assess and anticipate their future performance.

However, the previous studies suffer from the following limitation. Because IT applications nowadays have multiple objectives and purposes, they can be included in more than one categories depending on how organisations use them (Lucas, 1999). Thus, the classification of IT applications in a certain type of IT is not a reliable way of measuring and comparing IT intensity across organisations. For example, a reservation system can serve as an informational, transactional and strategic IT application depending on how hotels use it. Hotels with a Website cannot be automatically considered as having a transactional IT, because they might only use it for disseminating information and not for online reservations. In this vein, each IT application has to be measured individually depending on how each hotel is using it.

Overall, it is evident that little consensus exists in the literature on assessing IT's impact (Strassmann, 1985; Berger, Kobielus and Sutherland, 1988; Parker, Benson and Trainer, 1988; Keen, 1991). However, Markus and Robey (1988) argued that there is a need for a shift in the direction of research on the IT productivity paradox from technological imperative to organisational imperative studies. The technological imperative studies assume a direct causal relationship between IT investments and productivity and they are contrasted against organisational imperative studies that view productivity gains as a result of a deliberate alignment between managerial and technological choices (Figure 6.3.1.3.e).

Figure 6.3.1.3.e Technological Imperative Vs Organisational Imperative: Direct Vs Mediated relationship between IT and Performance



Source: Francalanci and Hossam (1997)

The majority of studies are of a technological imperative approach, because they assume a direct causal relationship between higher IT investments and productivity improvements, and they have resulted in negative correlations between IT expense and company productivity (Loveman, 1988; Powell and DenMicallef, 1997; Strassmann, 1990; Venkatraman and Zaheer, 1990). However, as it was previously analysed, for more than 20 years, researchers have discussed how technology alone is an insufficient predictor of variance in productivity. Thus, the exclusion of other variables in productivity models may distort the measurable influence of technology and provide results with lower explanatory value. As Francalanci and Hossam (1997, p. 228) argued "*evidence supporting this causal model is appealing to establish IT per se as a critical determinant of productivity, but it is also subject to theoretical criticism*". Moreover, in their study, Fracalanci and Hossam (1997) illustrated the positive effect of aligning IT expense and operations needs and demonstrated that the benefits of investing in IT can be uncovered from an organisational imperative perspective even when IT alone has a negative contribution to productivity. However, they recognised that operation needs are only one of the several organisational variables that interact with IT in explaining variance in productivity.

Overall, it is clear that there is a general agreement that the type and level of IT use should be considered if more reliable and consistent results on the relationship between IT and productivity are to be gathered. It is also highlighted (e.g. Willcocks et al, 1998) that an understanding of the IT productivity impact requires the consideration and impact of the continually evolving IT capabilities and features. Therefore, in the effort to identify different types and sophistication of IT applications that could lead to productivity gains, the following steps are necessary: 1) define IT and identify its components; 2) identify and analyse the evolving IT capabilities and features as well as their impact on businesses; 3) with knowledge gathered in steps 1 and 2 build a theoretical framework that would identify and analyse the ways in which exploitation of IT assets and capabilities can enhance productivity; and finally 4) use these findings in order to develop an IT application framework that would be able to explain how different IT deployment leads to increased productivity. This framework is valuable because it can be used for measuring different types of IT deployment (that theoretically should lead to productivity gains), which in turn can be linked and related to productivity metrics.

The rationale of this study is also compatible with the well-known mantra "what gets measured gets managed" and the behavioural implications of measurement (e.g. *"metrics: you are what you measured"*, Hauser and Katz, 1998, p.1) that several authors have claimed. Studies linking IT costs to performance metrics reinforce the perception and attitude to controlling costs and efficiency of IT projects whereas a more strategic and innovative approach to ICT is nowadays required. As Willcocks and Lester (1996, p.279) claimed, the emphasis should be towards *"the management and "flushing out" of benefits by innovative exploitation of ICT"*, meaning research has to investigate effective ways and applications for exploiting the continually evolving ICT capabilities and features.

6.3.1.4 The level of analysis at which the research is undertaken

Studies investigating the IT productivity impact have been categorised into four types, each of which involves a different level of aggregation, a different unit of analysis. However, studies from all three types suggest both a paucity or lack of productivity payoff as well as productivity gains from IT, but research findings and analyses should be interpreted under the light of the following advantages and disadvantages concerning the level of analysis used in these studies.

The first type of studies analyses productivity levels and IT investments in an entire economic sector for a period of years. Productivity and IT investment are compared across several industries in a second type of research whereby sectors with greater IT penetration are expected to show greater productivity over time. A third type focuses on representative samples of firms within one industry and looks at whether firms with higher IT investment have higher productivity than similar firms with less IT. The fourth type of research focuses on the impact of IT on specific organisational processes.

However, economy- and industry-level analyses may confound results due to the aggregation of data and heterogeneity of units of analysis. Baily and Gordon (1988) concluded that one of the explanations of the productivity paradox is that although IT can be productive at the firm level, IT may make little contribution to aggregate growth. Carlsson (1990) also advocated that the problem arises because macrodata do not capture or account for firm-level (micro) phenomena such as technical efficiency, best practice technology and differences in investment behaviour among firms. To add more, the aggregation of data and measurement errors make interpretations of the results extremely difficult and their implications for decision-making are not clear. Brynjolfsson (1993) also argued that economy- and industry- level analyses can lead to obscured results because of displacement effects. The latter refers to the situation whereby benefits of IT investments in one industry balanced out IT costs incurred in another industry, which in turn leads to a zero total IT effect. Generally, economy and industry level macro-measurements revealed productivity slow downs, but because of the previous the question is whether firm-level analysis will show similar results.

Osterman (1990) claimed that the IT productivity and the firm cannot be determined in isolation, meaning that the former has to be determined in relation to other factors such as human resource strategy and external economic institutions and so a multi-factor, firm-level productivity analysis is believed to be the most appropriate line of inquiry. Menon (2000, p. 9) also strongly advocated that more realistic models can be formulated at the firm-level, because *"inefficiencies in resource allocation of different inputs can be modelled and managerial behaviour stemming from bounded rationality can be accounted for"*. That is to say that the amounts of input factors would relate a more realistic account of their contribution to production. Moreover, considering that the productivity impact of IT can be very contextual and industry specific, firm level analyses also benefit from the fact that environmental factors are the same for all subjects. Specifically, it has been argued that a firm level analysis is possible to control for firm-specific and industry specific aspects that might confound productivity studies (Menon, 2000) as well as to study substitution and complementarity effects between IT and other factors of production (Dewan and Min, 1996). This study focuses on a sample of homogenous firms, i.e. properties from the hotel sector that have a three star rating, in order to minimize confounding from other factors when eliciting the productivity contribution of IT.

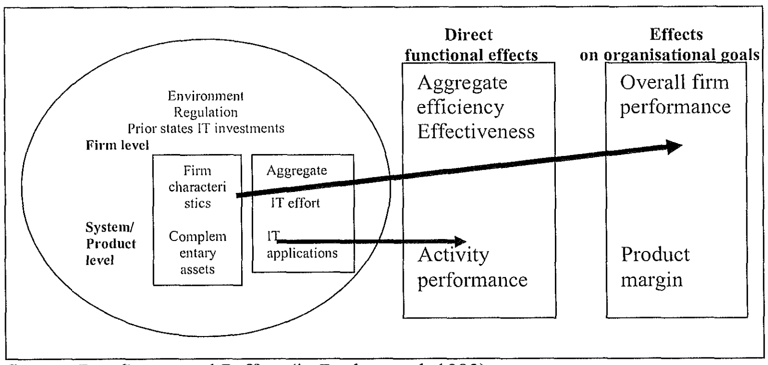
On the other hand, building on the theoretical developments of Business Process Improvement (BPI) and Business Process Reengineering (BPR) (e.g. Davenport, 1993; Hammer and Champy, 1993) that supported a process-oriented view attempting to link intermediate process variables to firm level performance variable, some recent studies have adopted a "process-oriented" view that examines the effects of IT on intermediate business processes (e.g. Barua et al, 1995; Mooney et al, 1995; Soh and Markus, 1995). However, because of the specificity of business process and their business dependent configuration, it is evident that such an approach is difficult to be implemented on a large scale. Large-scale research would require the identification of a lot of businesses having the same process so that comparisons and generalisations could be derived. Thus, Menon (2000) identified the following serious problems of process-level analyses: difficulty in data collection and insufficient sample size, since a significant number of firms with similar processes should be found; difficulty in separating IT effects from non-IT effects within a process; the validity in the generalisation of results arising from the difficulty of finding similar processes performed with and without IT across firms.

On the contrary, process-level studies have also been claimed to be useful because IT implementation affects processes before they affect the firms using those processes. Specifically, Kelley (1994) argued that the fact that previous econometric analyses investigating the impact of IT on productivity have found little evidence of an IT payoff is not surprising because these studies have suffered from a lack of specificity in conceptualising the link between technology and the affected process(es). However, earlier, Morrison and Berndt (1990) had argued that additional problems of measurement errors occur when studying a specific process, because improving a process may cause inefficiencies in other processes. They went on to argue that by moving towards an industry or firm level rather than a specific process these problems can be removed because the totality of processes is considered. Further, a firm level-analysis also considers synergy and complementary effects between IT applications that a process level analysis is unable to consider.

Because of these limitations process level studies are rarely used. In fact, Kelley's (1994) study was the only process level analysis found. In investigating the effect of programmable automation used in manufacturing operations for several firms, her findings revealed that process efficiencies from automation are related to productivity gains. Despite the limitations of her study, the findings support the argument that productivity and efficiency are intricately linked and so, any reasonable study of IT productivity must model inefficiencies due to operation (i.e. conversion of inputs to outputs) and management (i.e. the use of management practices). To that end, a methodologically sound study on the IT productivity impact should use techniques that consider inefficiencies (such as production functions and DEA) and avoid those that do not (e.g. ratio or regression analysis). A more detailed analysis on the different data analysis techniques is provided in the following section.

In reviewing the variety of studies of the IT productivity paradox, Dos Santos and Peffers (in Banker et al, 1993, p. 519) developed a slightly different framework for categorising research studies. Indeed, their major contribution was that they managed to illustrate the implications that the level of analysis at which both productivity and IT are being measured can have on the methodology design of research studies. Because of that they argued that this framework could form a basis for research on the impact of IT. The framework suggests that the impact of IT investments may be measured, for the sake of simplicity, at two levels of aggregation, from discrete, low impacts on individual activities within firms, to impacts on overall firm performance. At the lowest level, one could measure the impact on those activities within the firm that are directly affected by IT investments. At the higher level, the impact of IT investments on the overall performance of the firm could be measured. IT investment impacts, however, must be considered within a larger context, defined by factors internal or external to the firm that determine the impact of an IT investment. Figure 6.3.1.4.a illustrates this framework

Figure 6.3.1.4.a Framework of analysis for IT productivity impact studies



Source: Dos Santos and Peffers (in Banker et al, 1993)

The first column represents the existing state of the business and the assets currently owned (or controlled) by the firm. The second column represents IT-related actions taken by managers, that affect resources allocated to IT applications. The circular area around these two columns is meant to show that environmental factors, such as industry structure, regulations and the level of the technological resources that are available to firms could also determine IT impacts. The outcome of IT investments may be measured in terms of the direct functional effects of IT applications. These are effects which are related to the function or purpose of the IT, such as the effects on efficiency or levels of achievement for specific activities. Such measures are primarily useful to firm's managers. IT impacts may also be measured in terms of organisational goals, such as productivity and profitability.

At the lowest level, the independent variable of interest (the source of impact), the dependent variable (the outcome), or both can be at the individual IT system or project level. At the higher level, firm level studies can be conducted, where the impact of firm-wide allocation of resources to IT activities on firm-level performance (the independent and dependent variables are firm-level measures). At the highest level, the impact of IT investments on an entire industry can be measured.

Dos Santos and Peffers (in Banker et al, 1993) argued that the choice of the level of analysis affects the sensitivity of measurement and the plausibility of alleged causal relationships. So, effects of changes in aggregate resources allocated to IT by firms may be more easily linked to firm-level performance, than are resource allocation decisions at the application level, because the impacts of specific applications may not be observable at the firm level as: many other factors affect firm-level performance and it is difficult to control for all these factors to determine the contribution of an individual IT investment; intermediate effects may not translate to firm wide outcomes; and intermediate outcomes do not provide evidence that IT can have an impact on the firm level, because for example, competing firms may do the same or because performance in other activities degrade. On the other hand, causal relationships between individual IT applications and performance are more plausible when the analysis is conducted using performance measures that are easily linked to the effects these systems are expected to have. These are similar arguments to those previously mentioned.

Based on the IT impact model, Dos Santos and Peffers (in Banker et al, 1993) categorised studies seeking to determine the effects of IT investments on firm performance into two streams (Table 6.3.1.4.a):

a) functional IT investment studies determining the effects of specific IT applications on functionally related performance at activity or aggregated levels;
b) aggregate IT investment studies determining the effects of changes in aggregate levels of IT investment on overall firm or business unit performance, in terms of either functional effects or organisational goals.

Table 6.3.1.4.a Type of studies investigating the effect of IT on firm performance

		Sources of impact	
Level of aggregation		*IT application*	*IT investments*
Impact of outcomes	*Firm level*	Functional	Aggregate
	System/product level	Functional	Aggregate

Dos Santos and Peffers (in Banker et al, 1993) argued that the limitation of functional studies stems from the lack of a direct link between the observed, functionally related performance effects and measurable performance in terms of organisational goals, as none of these studies measures effects of IT on firm level performance. For example, Venkatraman and Zahher (1990) concluded that IT supported increases in the quantity of insurance sold by agents, but without simultaneous evaluation of the quality of these sales, it is impossible to tell if agents were using the technology to achieve higher revenue by selling riskier policies. Therefore, the overall result might not be a positive effect on the firm. Unfortunately, this limitation is common in field research where within-firm performance measures are used.

On the other hand, studies on aggregate IT investments are important because they provide evidence that IT investments could affect firms' ultimate outcomes as well as investigate whether IT can affect firms differently because of differences in firm characteristics. The usefulness of such studies is limited however, because of their reliance on aggregated measures of IT investment, which in turn did not allow the investigation of the relationship between specific IT applications and performance. In addition, the measures of performance used in these studies were aggregate measures of resource utilisation (also functionally related to the purpose of IT efforts), whose relationship with measures of overall performance is not easily inferred. Thus, one cannot conclude from these studies that efficiency improvements result from investments in specific IT applications, or that specific IT investments can increase the value of the firm.

The most important potential contribution of research aimed at determining the value of IT investments is that it can provide guidance to IT resources allocation decisions. Studies that link aggregate IT investments to firm performance are unlikely to provide insights that will help managers make these investment decisions. On the other hand, it is studies of investments in specific IT applications that are more likely to provide results that can be useful to managers responsible for making investment decisions.

The reason for that is that it is easier to study performance impacts at the activity level, because expectations can be developed based directly on the features of IT applications. However, effects on these activities are not easily related to organisational goals. As a result, as already discussed in section 2.2.2, activity-based measures are not necessarily good measures of impact on organisational performance. Because of that Dos Santos and Peffers (in Banker et al, 1993, p. 521) concluded that "*research is required that would overcome the limitations of the two previous research streams by making a distinction between different IT investments and taking into consideration that activity based results are not always translated into firm level outcomes*".

This study proposes a methodology that aims at overcoming the two previously identified limitations. This is done by using: disaggregated non-financial IT metrics that account for the individual IT applications as well as the level of their implementation / sophistication; multiple disaggregated and functional oriented productivity metrics that are more likely to be linked to IT applications; and a stepwise DEA, a statistical method that can construct an overall efficiency frontier by simultaneously analysing multiple productivity inputs and outputs and identifying which of them significantly contribute to overall productivity metrics. Thus, the DEA technique is argued to overcome: the relationship problem between intermediate metrics and ultimate organisational performance; and the problems regarding the complementarities, synergies and displacement effect that can be found between resources as well as between IT productivity impacts in different functional areas and/or resources, because multiple inputs and outputs are considered at the same time.

6.3.1.5 The statistical method used to relate IT with productivity metrics

As previously explained, there have been economy-, industry-, firm and process-level analyses that have studied the productivity impact of IT. In general, economy wide and industry wide studies have used growth accounting (or index numbers e.g. Harris and Katz, 1990), econometric techniques (Schmidt and Lovell, 1979; Kumbhakar, 1990), regression analysis or ratio analysis (i.e. determining performance-to-invest ratios). Ratio and regression analysis may be the only method of analysis in the economy and industry level as no additional information, economic or behavioural, is available for modelling an industry or the economy. However, previous studies on the effect of IT at the firm level have also used ratio analysis, regression models or a combination of both.

Apart from the previously mentioned (section 2.2.4) disadvantages of these methodologies for productivity measurement, several other pitfalls have been reported for these methodologies when used to investigate the IT productivity paradox. Among the several major differences between the two techniques, the index numbers technique assumes away inefficiency in production which econometric techniques are capable of modelling. Moreover, studies that used single-equation regression analysis suffer from the fact that the latter can lead to inconsistent estimates of parameters and so to wrong conclusions (Menon, 2000). On the other hand, a system of equations built on robust microeconomic theory leads to consistent estimates (Greene, 1993) and more importantly, leads to results that can be interpreted usefully. However, econometric techniques make several assumptions to simplify computation and are subject to specification error, e.g. economies of scale, certain forms of production functions, use of price deflators, etc. Since productivity and efficiency are inextricably linked, the productivity approach is a more appropriate technique than the index number approach for modelling inefficiency of production that may result from various reasons (Menon, 2000). To that end, as previously explained both DEA and production functions can identify the size of both allocative and technical inefficiencies.

The major advantage of DEA and production functions is that they can simultaneously account for multiple inputs and outputs, whose importance is highlighted by Menon (2000). In investigating the impact of IT on the productivity of the healthcare sector using a production function methodology, Menon (2000, p. 44) concluded that *"future productivity research must carefully consider multiobjective and multioutput models in order to determine the impacts of input factors"*. However, DEA is a non-parametric technique, while production function is a parametric technique. In parametric techniques a functional form for the technology that transforms inputs into outputs is assumed, while non-parametric techniques do not assume a functional form but involve estimation of the "best practice" frontier from the sample data (Lovell, 1993). There are advantages and disadvantages of using either of these two techniques for productivity analysis and the major differences centre around error from noisy data and specification error (Lovell, 1993). Parametric techniques attempt to model noise in the data whereas nonparametric techniques combine noise and inefficiency. On the other hand, parametric techniques could suffer from specification error, which is not a problem in nonparametric techniques. Non-parametric techniques place a weight on outlier observations whereas parametric techniques estimate average behaviour and discard outliers (Charnes et al, 1994, p. 9). However, research that tried to investigate whether the choice of one of these two techniques would had any significant effect on studies investigating the IT productivity impact provided negative evidence for the latter (e.g. Menon, 2000, Anderson et al, 1999).

Indeed, researchers have recently recognised the benefits of DEA for investigating the relationship between IT and performance. However, only a few studies using DEA for such purpose were found. Banker et al (1990) used DEA to determine whether there was a difference in performance between Hardee's restaurants that implemented a new cash register point-of-sale and order-coordination system and those that did not. Specifically, he used DEA for measuring efficiency and then conducted t - tests between IT users and non-users by which significant performance differences were found. Paradi et al (1997) used DEA to evaluate a group of software development projects at a Canadian bank. One way the framework in this study extends these previous works is by applying DEA at a more macro level across multiple organisations coming from the same sector, i.e. the three star hotel sector (the validity of DEA increases when benchmarking partners share similar operational processes).

However, although two studies investigating the IT productivity paradox have actually applied DEA at an industry level, these are limited by the fact that financial IT metrics (IT capital expenditure metrics) were incorporated into DEA models.

Dasgupta et al (1999) used a combination of various DEA models and other non-parametric techniques in testing the influence of IT investments in firm productivity. IT budget and IT employees were used as the inputs to the DEA models, while a single aggregate output metric (net income) was used as a DEA output. Their findings revealed a negligible effect of IT on performance, but they highlighted that future research should focus on specific types and deployment of IT investments in order to identify how organisations can better exploit their resources.

Shafer and Byrd (2000) used the following inputs and outputs of 440 companies in their DEA model: three inputs related to IT investments as provided by Computerworld (information systems budget as a percentage of sales, an organisation' s total processor value as a percentage of sales and the percentage of the IS budget allocated to training) and two output metrics five year compounded annual income growth and five year compounded annual revenue growth. Recognising the fact that the DEA results are only meaningful if appropriate inputs and outputs are specified, Shafer and Byrd (2000) identified the following limitations of their research: 1) use of limited and aggregated inputs and outputs, while a number of other variables could have been included, e.g. number of PCs per employee, market share, return on investment etc. since disaggregated data in other resources were not also used substitution and synergy effects were not considered; and 2) use of data that are collected for other purposes.

Moreover, the previous two studies also face the following methodological limitations: a) specific deployment of IT was not considered; and 2) the amplifier effect of IT was not considered, as efficient and inefficient firms were not firstly identified. In this vein, this study aims at overcoming these problems.

6.3.2 Mismanagement problems

Brynjolfsson (1993) claimed that one of the reasons for the IT productivity paradox is the mismanagement of information and technology resources. However, several other authors have argued and considered the possibility that a portion of the productivity paradox is attributable to mismanagement. Schrage (1997) described a rather colourful variation of the productivity paradox. He said that companies have wasted billions of dollars "believing the big lie of the Information Age". According to Schrage, the spending spree on IT was justified by a "beautiful hypothesis" that companies that had more and better information could improve their financial performance and competitive position. The hypothesis was defeated, according to Schrage, by an "ugly fact" that managers had acted irresponsibly in relying on technology to solve fundamental problems. Indeed, recent empirical findings of Strassmann (1990, 1997) indicated that the lack of any significant correlation between the investment in IT and performance points to possible irrational behaviour of management and bad, or lack of, exploitation of IT resources.

Actually, what Schrage (1997) calls a "beautiful hypothesis" was developed over the years and was based on several studies (e.g. McFarlan, 1984) suggesting that IT could be a source of competitive advantage. It can be argued that companies responding to these propositions and ample anecdotal evidence joined the IT bandwagon and invested ever-increasing amounts in IT. Unfortunately, not all of this investment was successful, while Stratopoulos and Dehning (2000) argued that the majority of IT projects continue to fail, while recent developments indicate that this trend may continue because it is fed by the e-commerce revolution. The combination of increasing IT investments and of high failure rate of IT projects can be argued to be another way to express Brynjolfsson's (1993) and Bakos' (1998) concept of mismanagement, because a high percentage of the amount invested in IT failing to have a positive impact on the performance of the company may obscure any correlation between IT investment and firm productivity.

The natural corollary of this explanation is in the form of a proposition suggesting that control for mismanagement should lead to a statistically significant positive correlation between IT investment and financial performance. However, several studies point to the fact that this will not be enough because IT is not an isolated island within the organisation (Strassmann, 1990 and 1997). The sheer completion of a project on time, on budget and with the required specification is not enough to lead to superior financial performance. After reviewing thirteen studies on the business value of IT, Kauffman and Weill (1989) concluded that although variability in IT performance is bound to affect the potential value to be gained from IT investment, it is rarely a good way to use it in isolation in order to measure the productivity impact of IT. In methodological terms, this means that system performance is a mediating, not criterion, variable. Problems regarding IT mismanagement are also compatible with and reflected in previous analysed arguments regarding the metrics used for measuring IT. Indeed, it has been argued that concepts measuring IT performance were not considered as appropriate and adequate metrics for investigating the IT productivity impact, as Weill's (1990) conception of conversion effectiveness and its critique by Markus and Soh (1993) confirmed that good management of IT is only a variable that can help us understand why there is a relationship between IT and productivity if such relationship actually exists.

On the other hand, another group of authors gave their interpretation to the mismanagement problems explaining the IT productivity paradox. These authors considered mismanagement problems not as the bad management of IT per se (i.e. technical and project management problems) but rather as bad adaptation and incorporation of IT within organisations and processes (i.e. business management problems). This is illustrated in the fact that many companies might invest in the same technology, but only those who manage successfully to integrate the IT into their business processes will be able to add value to the company. According to Porter and Millar (1980), IT is the conduit that links the processes within an organisation and it is in this way that IT add value to the company. Thus, superior financial performance will only be the reward of companies who have not simply completed IT projects, but have successfully integrated IT into their business processes. That is to say that the mismanagement problem can in some extent be overcome by investigating and measuring how firms are applying and exploiting ICT assets and capabilities.

That was also advocated and confirmed by Stratopoulos and Dehning (2000), who argued that one reason that they found a financial performance advantage is that the companies that they studied were evaluated based on how well ICT of the company were positioned to service its business needs. Menon (2000) also concluded that research on the productivity benefits of IT would reveal more useful information when the different types of IT are being considered. Osterman (1990) argued that although huge amounts of money is spent on IT capital investment little time and effort is invested in trying to find effective uses of IT.

Wigand et al (1997) also advocated that studies that fall into the classical pattern of investment calculations for an isolated ICT investment object have failed to investigate the link between ICT and productivity, because aside from the traditional investment costs for technology other associated management actions regarding changes to adjust for organisation, process and human work should also be considered. In this vein, Wigand et al (1997) also regarded IT mismanagement problems as a crucial explanation to the IT productivity paradox and related them to incorrect deployment of ICT, which is illustrated in insufficient reorganisation of organisational processes and the digitisation of existing processes without any adaptation to the organisational structure that in turn lead to huge inefficiencies. Indeed, firms typically design and use new IT applications to improve what is currently done, by doing it in more efficient manner, rather than thinking about these applications as opportunities to reengineer and or redefine the organisation. According to Dos Santos and Sussman (2000, p. 431), this represents a *"no-what"* thinking (improving the status quo) rather than a *"what-if"* thinking (creating a vision of the future) towards IT. In this vein, Wigand et al (1997, p. 153) argued that the IT productivity paradox can be solved *"by appropriate adaptation of ICT, organisational goals, strategies and processes in the sense of organisational fit"*.

Thus, IT investments must be accompanied by careful redesign and/or restructuring of the organisation to obtain many of the anticipated benefits of the investment. Yet, the IT productivity paradox is that even though organisations invest in the latest technology to increase efficiencies and performance, failure to redesign and reorganise delays the return on that investment (e.g. Malone and Rockart, 1991; Dos Santos and Sussman, 2000; Devenport, 1993). Actually, as Dos Santos and Sussman (2000) argued this paradox has held true for all the major IT innovations from simple transaction processing systems to database management systems and office systems to the new generation of applications brought with the Internet. For example, by simply making available ATMs to bank customers, banks did not produce many of the potential benefits that could have obtained. Maximum benefits from ATM deployment did not come until banks abandoned internal structures and processes based upon accounts and introduced processes focused on customers.

Leaving aside concerns regarding data reliability or methodology, Wilson (1995, p. 245 and 246) offered two polar explanations or possible "stories" about the chain of causation, based mainly on different assumptions of firm behaviour, specifically on how firms respond to environmental changes. According to the first story, *"the Sudden Transformation Response"*, the discontinuity in the IT capital productivity curve is a manifestation of a wide-scale breakthrough response by firms in how they use IT (e.g. BPR, downsizing, spinning off), triggered by environmentally driven pressures to restructure internally (Roach, 1991; Brynjolfsson and Hitt, 1993). The story of the *"Delayed Response to Evolutionary Process"* assumes that the discontinuity in the IT productivity curve is a sudden but long awaited manifestation of an evolutionary process of learning, experimentation and adaptation of firms in productively using IT that is characterised by an extraordinary extended learning curve. According to Wilson (1995, p. 246) *"one must look inside the firm and between firms in the same industry to determine which proposition has greater validity"* as well as to the internal workings of firms and how they use IT. To that end, Wilson (1995, p. 249) highlighted the need to identify and distinguish between *"high IT productivity"* performers and *"laggard IT productivity"* performers within specific industries and then conduct an in-depth examination of the internal processes giving rise to these performance differences.

Dos Santos and Sussman (2000) identified two reasons for the IT productivity paradox due to the delayed IT-led reengineering and restructuring initiatives in organisations: a) failure of strategic thinking; and b) failure of senior management to overcome resistance to change created whenever IT is initially introduced or when managers migrate from one system to another. Moreover, evidence from business process re-engineering research has also indicated that there is no correlation between size of IT expenditure on re-engineering projects and resulting productivity impacts (Willcocks and Lester, 1996). Thus, as Willcocks (1996) argued in business process re-engineering, as elsewhere, it is the management of IT and what it is used for rather than the size of IT spend that counts. Davenport (1993, p. 46) also argued that *"researchers trying to understand the benefits of IT must begin to think the process improvement and innovation as a mediating factor between the IT initiative and the economic outcome".*

Overall, that is to say that in methodological terms the mismanagement problem can be solved by using appropriate metrics of ICT that reflect how businesses have adapted and use ICT to support and enhance their processes and organisational needs, i.e. by using IT metrics reflecting types and degrees of ICT deployment. That issue was also extensively discussed in the previous section, i.e. mismeasurement problems.

6.4 Summary

A great number of both qualitative and quantitative studies investigating the IT productivity impact has been reviewed and analysed. Although qualitative studies tend to illustrate a positive relationship between IT and productivity their reliability and generalisation is very questionable. Quantitative studies lead to non conclusive arguments regarding the productivity impact of IT. Indeed, quantitative studies have been clustered in two categories those revealing a positive impact of IT on productivity and those showing a no significant or negative IT productivity effect. The elusive relationship between IT and productivity illustrated in previous studies has resulted in the development of the concept of the IT productivity paradox.

It has though been argued and illustrated that the productivity paradox is a result of a combination of several methodological problems of previous research that refer to two major issues mismeasurement and mismanagement concerns.

Mismeasurment issues refer to five concerns. First, the quality of the data used and of the data analysis. Specifically, several studies have used data gathered for other purposes whose reliability is also questionable. Previous studies do not also make data analysis that distinguishes the impact of IT on high and low performing firms. The latter is crucial important because of the amplifier effect of IT, i.e. that IT reinforces existing management practices (both good and bad). Previous studies are also limited to the metrics that they have used for measuring productivity. As Brynjolfsson (1992) argued the contradictory results are mainly due to the fact that different studies defined and measured different concepts and so, a clear definition and measurement of the concept being addressed should be first done. Productivity metrics used should also reflect qualitative aspects, because IT can significantly affect them. Third, mismeasurement problems referring to the metrics measuring IT are found in several disciples, e.g. IT management, information management, business management, operations management and resource based views (RBV) of the firm. Their main argument refers to the fact that IT metrics should reflect how the evolving IT capabilities and tools are being used within business operations. Fourth, it was argued that the level of analysis at which research is undertaken can crucially affect the quality of research. Macro level analyses (industry, economy level) are limited in that they can obscure productivity effects, while process level analyses cannot be generalised even if they can easily be implemented (problems regarding data collection). However, the level of analysis should also address the issue regarding at which level ICT is measured, i.e. aggregate IT metrics or individual factors. Decisions for both productivity and IT levels of analysis should take into consideration how synergy effects are going to be addressed. Last, the statistical method relating IT with productivity is also crucial. In this vein, the advantages of DEA relative to other techniques were analysed.

Mismanagement problems mainly focused on the impact of the use and management of IT resources on productivity. It is however illustrated that ways of the development of appropriate IT metrics can overcome such problems.

Within this framework of unravelling the ICT productivity paradox, the ways in which this study addressed these methodological issues were provided. However, a more detailed analysis and arguments of the soundness of the methodology of this study is provided in chapter eight.

6.5 Conclusions

According to Wilson (1995) there are two fundamental weaknesses concerning existing research on the IT productivity paradox:

- The lack of systematic application of economic models and other existing relevant theories to the data and the facts;
- An absence of any useful "middle range" or "grounded" theory that provides the necessary foundation for formulating the testing hypothesis. That is necessary in order to avoid various threats to internal validity.

Regarding the first weakness, Wilson (1995) highlighted the fact that the productivity paradox can be explained by solving measurement issues (e.g. construct measurement and data analysis), while for the second one, she (1995, p. 246) argued that "*increased effort must be directed at the tasks of knowledge creation, specifically in the form of developing better stories that explain the causal chain linking a firm's investment decision making process and implementation and measurement systems to cumulative effects on IT spending on industry and sector productivity*".

Wilson however, has failed to illustrate the interrelationship between these issues. That is to say that theories and/or assumptions that underline research on investigating the IT productivity paradox directly influence the way constructs are measured and analysed. This is supported by several authors (e.g. Brynjolfsson, 1993) when arguing that the productivity paradox is a result of a combination of problems.

In this vein, as concerns issues regarding productivity definition and measurement as well as theories explaining productivity improvement, these have been extensively analysed in chapters two and three. Moreover, issues regarding data analysis are addressed with the use of the DEA, which is explained and argued in chapter four.

The study also developed a way of measuring ICT investments that is based on a theoretical framework that is argued to incorporate and summarise theoretical underpinnings of how ICT assets and capabilities can affect productivity. To that end, ICT assets were first defined and then an analysis of the evolution of the ICT capabilities and as well as of their impact on businesses (both on the asset and operating frontier) was provided (chapter five). Based on these, a theoretical framework explaining the ICT impact on productivity was proposed and analysed (chapter five), which in turn formed the basis for developing a framework for measuring ICT applications. Within the context of the hotel sector, the model for measuring ICT applications and the impact of its dimensions on productivity are analysed and illustrated in chapter seven, whereby ICT applications in the hotel sector are explained in depth.

Overall, it is argued that the methodology of this study investigating the productivity impact of ICT overcomes most of the problems explaining the productivity paradox. A detailed analysis of the methodology of the study is given in chapter eight.

CHAPTER SEVEN

Hotel industry and hotel ICT applications

This chapters aims at presenting the contextual framework of this study. It describes and investigates the three star hotel sector wherein this study was carried out. To that end, the first part starts by providing a definition of hotels in general and of the specific features provided by three star hotel properties. Data on the structure, size and operational characteristics of the hotel sector in UK are provided in a following section. The second part of this chapter aims at investigating and illustrating ICT applications found at the hotel sector by following the proposed framework for analysing ICT applications for identifying the impact of ICT on productivity. Specifically, ICT applications are analysed by investigating what business processes they impact, as well as how the exploitation or lack of use and management of their networking/integration and information capabilities and features can impact on productivity. Finally, data regarding the adoption and diffusion rates of ICT within the hotel sector as well as factors that may affect the former are provided.

7.1 The Hotel Sector

7.1.1 Defining a hotel

The hotel sector belongs in the accommodation or hospitality component of the tourism industry that provides travellers with somewhere to stay and sustenance while travelling to or staying in their destination. In particular, the hotel sector represents the commercial and serviced type of accommodation (Youell, 1998). However, as Vèrginis and Wood (1999) argued, although an increasing amount of research is being conducted in hospitality management, problems exists at the very basic level of defining what the hotel industry is and what constitutes a hotel.

The WTO defines a hotel as (Todd and Mather, 1995, p. 7):
"hotels and similar establishments ... are typified as being arranged in rooms, in number exceeding a specified minimum; as coming under a common management; as providing certain services, including room service, daily bed making and cleaning of sanitary facilities; as grouped in classes and categories according to the facilities and services provided"

However, this definition creates problems since translation of these terms can substantially differ in different countries. Medlik and Ingram (2000) argued that the rich variety of hotels is seen from the many terms in use to denote the particular types, e.g. luxury, resort, commercial, residential, transit etc. They also went to argue that although each of these terms may give an indication of a hotel feature (e.g. location, guest type), it does not describe adequately a hotel's characteristics. To that end, one should use a combination of terms each of which describes a hotel according to certain criteria. Medlik and Ingram (2000) identified the following criteria:

- *Location;* hotels in cities, in large or small towns, in inland, coastal and mountain resorts etc
- *Position of the hotel in its location;* e.g. hotel in the city, in the suburbs, along the highway etc
- *Reference to modes of transport;* e.g. railway hotels, motels, airport hotels etc
- *Purpose of visit;* business hotels, holiday hotels, convention hotels etc
- *Short or long duration of guests' stay;* e.g. transit or residential hotels
- *Range of its facilities and services;* e.g. hotels open to residents and non residents
- *Availability of a license for selling alcoholic liquor;* e.g. licensed and unlicensed hotels
- *Size;* there is no universal agreement regarding the cut off points of bed or room capacity for categorising hotels. These vary depending the size structure of the hotel industry in a particular country
- *Criteria regarding hotel grading and classification;* these again vary by country
- *Ownership and management;* e.g. independent, franchised, managed, group owned hotels etc

Before trying to categorise hotels in terms of their classification and grading the following definitions are provided (Callan, in Verginis and Wood, 1999, p. 31). Typical approaches to classification are where the stock of accommodation is sub-divided into categories, whereby each category consists of specified facilities, e.g. as the proportion of private bathrooms, minimum size of rooms, full-length mirrors etc. each country classifies differently, while also having a number of levels within each classification that signify the range of facilities that it is possible to measure (e.g. in self catering accommodation, in hotels, in guest houses). According to Medlik and Ingram (2000) hotel facilities include bedrooms, restaurants, bars, function rooms, meeting rooms and recreation facilities such as tennis courts and swimming pools and may be differentiated in type, size, type and level of service etc. In particular, service comprises the availability and extent of particular hotel services provided through its facilities; the style and quality of all these in such terms as formality and informality, degree of personal attention and speed and efficiency.

Grading is a qualitative assessment of the facilities described under classification assessing how good or bad are the facilities or services offered. Callan (in Verginis and Wood, 1999) analysed the different grading schemes that exist in the UK (i.e. those operated by the National Tourist Boards, the motoring organisations (i.e. Automobile Association [AA] and Royal Automobile Club [RAC] together with a number of commercial guides, e.g. Good Hotel Guide, Michelin etc).

This study focuses on the 3 star hotel sector according to the AA star classification scheme. The AA (1999, p. 6) specified the following minimum facilities and services for three star hotel properties as follows. Three star hotels are usually of a size to support higher staffing levels, and a significantly greater quality and range of facilities than at the lower star classifications. Reception and the other public rooms will be more spacious and the restaurant will normally also cater for non-residents. All bedrooms will have fully en-suite bath and shower rooms and offer a good standard of comfort and equipment, such as hair dryer, direct dial phone, toiletries in the bathroom. Some room service can be expected and some provision for business travellers. Appendix B details the minimum facilities and services for all star categories hotels.

7.1.2 The structure of the UK hotel sector

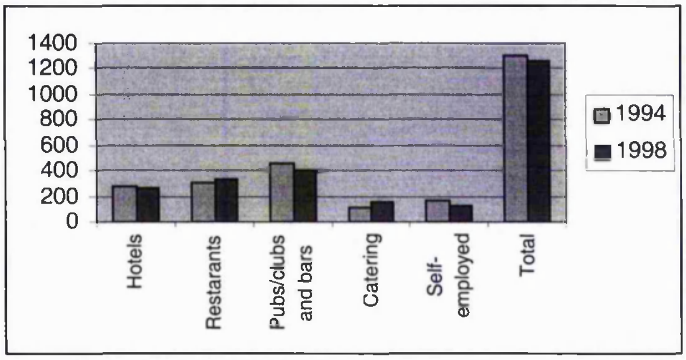
The hotel sector represents a substantial majority of hospitality enterprises in the UK (Table 7.1.2.a), which in turn are a great generator of employment (Figure 7.1.2.a).

Table 7.1.2.a UK Hospitality and Catering industry

	No of outlets				**No of outlets**		
Profit sector	1981	1996	1999	Cost sector	1981	1996	1999
Hotels	55,474	60,740	60,949	Staff catering	27,186	21,780	20,683
Restaurants	14,952	15,920	15,954	Healthcare	11,890	23,720	25,075
Fast Food	539	1,770	2,221	Education	37,820	34,580	34,429
Cafes/Take aways	34,204	30,990	29,270	Services/ welfare	3,210	3,260	3,355
Pubs	77,672	58,980	54,723	COST SECTOR TOTAL	80,016	83,340	83,543
Travel	816	1,290	1,359	[redacted]			
Leisure	41,414	47,475	48,523				
PROFIT SECTOR TOTAL	225,073	217,065	212,998				

Source: HCIMA (2000)

Figure 7.1.2.a Employment in hospitality industry (000s)



Source: HCIMA (2000)

7.1.2.1 Size of the UK hotel industry

The number of businesses operating in the hotel market has fallen significantly since the start of the 1990s (Table 7.1.2.1.a). Much of the fall was concentrated in the earliest part of the decade, when the economy was still feeling the impact of the recession and many business left in the market.

Table 7.1.2.1.a Number of UK hotel business, 1990 and 1995-2000

1990	14,410
1995	12,005
1996	11,450
1997	10,935
1998	10,695
1999	10,425
2000	10,250

Source: Key Note (2001)

However, as there is no formal way of gathering statistics regarding the hotel industry in the UK the exact number of hotel establishments is difficult to find. According to the British Hospitality Association (BHA) estimates that there are around 60,000 establishments in the UK offering some form of paid for accommodation under the banner of guesthouse or hotel. However, fewer than 23,000 are registered with a tourist board (registration is not compulsory in UK as in Northern Ireland) (Table 7.1.2.1.b). The Hotel and Catering Research Centre at the University of Huddersfield estimated that a realistic figure for the number of properties that could fit the definition of "hotel" in the UK is 18,000.

Table 7.1.2.1.b Number of hotels in UK registered with a tourist board, 1997-1998

	1997		1998	
	Hotels	**Bedspaces**	**Hotels**	**Bedspaces**
England	18,815	746,936	18,783	761,714
Scotland	2,456	96,790	2,494	101,734
Wales	1,397	50,494	655	50,494
Northern Ireland	139	8,714	139	10,049
TOTAL	22,807	902,934	22,071	923,991

Source: BHA (2000)

7.1.2.2 Size of hotel properties

Generally, small to medium-sized hotels either in terms of room numbers (Table 7.1.2.2.a) or size of income (Table 7.1.2.2.b) remain important in the hotels market, accounting for a significant share in terms of numbers. Indeed, the BHA reported that although major UK cities have hotels of up to 200 bedrooms or more, nearly half (48%) have fewer than 99 bedrooms and are independently owned, while the average size of all UK hotels is in the region of 20 rooms.

Table 7.1.2.2.a UK hotel industry, group and consortia hotels: by number of bedrooms, 1998

Hotel size (bedrooms)	Total number of bedrooms	Consortia bedrooms	Group bedrooms
1,000 +	1,441	-	1,441
500 – 999	14,176	1,301	12,875
200 – 499	44,256	5,596	38,660
100- 199	67,061	8,712	58,349
50 – 99	60,469	13,726	46,743
25 – 49	38,777	13,013	25,764
10 – 24	13,823	10,113	3,710
Less than 10	2,057	1,674	383
TOTAL	**242,060**	**54,135**	**187,925**

Source: BHA (2000)

Table 7.1.2.2.b Number of VAT-based enterprises engaged in the UK hotel market by turnover (£000, number and %), 2000

Turnover (£000)	Number of enterprises	% of total
1 – 49	460	4.5
50 – 99	2,005	19.6
100- 249	3,240	31.6
250 – 499	2,035	19.8
500 – 999	1,300	12.7
1,000 – 4,999	1,005	9.8
5,000	205	2.0
TOTAL	10,255*	100.0

* does not sum due to rounding

Source: Key Note (2000)

When data regarding hotel size in terms of number of rooms are broken down according to the AA star rating system, it is evident that the three star category (a market traditionally dominated by independent hoteliers) represents a greater majority of bedrooms than any other category, and in particularly in the consortia cluster of hotels (Table 7.1.2.2.c). Unclassified hotels have over 104,000 rooms, indicating that many of those hotels that choose not to enter a scheme are small establishments.

Table 7.1.2.2.c UK hotel industry, group and consortia hotels: by grade, 1998

AA classification	Total number of bedrooms	Consortia bedrooms	Group bedrooms
5 star	7,074	2,814	4,260
4 star	43,404	5,556	37,848
3 star	73,611	22,682	50,929
2 star	12,188	6,726	5,462
1 star	157	143	14
L-Lodge	1,233	88	1,145
U- Unclassified	104,393	16,126	88,267
TOTAL	242,060	54,135	187,925

Source: BHA (2000)

More current data (Table 7.1.2.2.d) illustrate that 3 star hotels in the UK still account for the greatest majority of UK hotels.

Table 7.1.2.2.d Star ratings of hotels with more than 10 bedrooms

Total number	13,069	100%
Not rated	7,987	61.11%
RAC rated	688	5.26%
1 *	177	1.35%
2 *	1,593	12.19%
3 *	1,727	13.21%
4 *	354	2.71%
5*	37	0.28%
Branded	506	3.78%

Source: BHA (2001) www.bha-online.org.uk

7.1.2.3 Ownership and management structure in the hotel industry

According to the Martin Information brand database (Sangster, 2000) almost 2,700 hotels in the UK, i.e. around 15% of the total UK hotel sector, are corporately owned. When looking at changes over the past years the increasing power of brands becomes more evident. Martin Information database revealed that although at the end of 1998 there were 197,000 bedrooms under corporate ownership by the end of 1999 this number swelled by 17% to 230,000. The bulk of this increase came from the expansion of the corporate sector (Sangster, 2000). However, the most worrying issue for independent hoteliers is the fast expansion of the budget hotel sector with brands such as Travel Inn and Travelodge adding new supply through new-builds.

The second clear trend is that the biggest brands are getting bigger and doing so rapidly as a result of the general consolidation that is taking place in the hotel sector worldwide, i.e. the mergers and acquisitions of smaller hotel groups by bigger hotel groups. So, worldwide, in the five years between 1990 and 1994, the value of deals was around £14 billion in total, while in the four years between 1995 and 1998 this number was more than £66 billion, i.e. nearly five times as much (Sangster, 2000). In the UK, within one year, the number bedrooms operated by the top ten hotel brands has increased by nearly 25% to more than 129,000 bedrooms (Table 7.1.2.3.a) from the position at the start of 1999 when the top ten brands had fewer than 85,000 bedrooms (Sangster, 2000).

Sangster (2000) argued that the major driver of the consolidation taking place in the hotel sector is the power of brand. Brands give access to several benefits such as marketing, reservation systems, sales networks and purchasing. In fact the stronger the brand the bigger the benefits, while brands can also result in a virtuous circle whereby brand power is amplified by distribution, which in turn helps brand awareness. This then leads to guests preferring that brand, giving premiums in terms of revenue per available room to those properties under the brand, which then increases returns to the property owner. Property owners are thus increasingly encouraged to adopt brands and the circle is complete.

Arthur Andersen (www.aa.com) cited five key reasons why strong brands are growing. These are that branded hotels: 1) typically obtain higher market shares; 2) often obtain price premiums from customers; 3) typically achieve higher investor returns; 4) offer avenues for potentially diverse means of further growth; 5) create customer loyalty and therefore generate more stable earning streams. Sangster (2000) pointed out that the high costs of central reservation systems and other essential technology for hoteliers coupled with the need to attain critical mass in brands has also led to the significant consolidation in the hotel sector.

To compete effectively in the increasingly consolidated hotel industry and to get access to funds and technology primarily limited to big brands, independents are clustering into hotel consortia. Hotel consortia are groupings of hotels, most of which are single, independently owned hotels, which share corporate costs such as marketing and distribution while retaining the independence of ownership and operation of the individual hotel members. Slattery (1992) reported that consortia membership in the UK is growing as unaffiliated hotels are trying to improve their performance and position in the market. However, as consortia operate by grouping together independently owned hotels and then marketing them as one single brand, the problems with this approach though are in the competing demands of providing consistency to the guest and allowing the independent owners to run their business in the way they see fit. Sangster (2000, p. 76) reported that consortia nowadays are rather weak on brand standards, *"generally being more a collection of hotels than what might be considered a hard brand"*.

The major hotel groups and hotel consortia in UK are provided in Table 7.1.2.3.a. Hotel groups operating three star hotels are highlighted in the Table. The three star hotel sector represents the midmarket hotel sector and it is so attacked on two fronts, i.e. from below the emerging budget brands (e.g. Travelodge, Travel Inn, Sleep Inn, Premier Lodge, Express By Holiday Inn, Ibis, Formule 1 etc) and from above by four star hotels. Best Western, a US originated group which is also the biggest brand in the UK after its merger with the UK consortium Consort, also sits in the midmarket segment competing against brands such as Regal's Court and Posthouse. The flexibility and the low capital cost of the consortium approach have allowed it to gain maximum distribution quickly, moving ahead of its rivals. However, the moves by the directly managed chains to stiffen brand standards in their hotels will make Best Western's task of presenting itself as a consistent product to guests increasingly tough.

Table 7.1.2.3.a Major UK Hotel Groups and consortia

Name	No of hotels	Rooms
Forte hotels (79 Posthouse, 47 Heritage, 7 Meridien, 4 London Signature, 200 Travelodge)	337	30,754
Whitbread Hotel Group (25 Marriott, 10 Courtyard by Marriott, 28 Swallow, 250 Travel Inn)	323	24,022
Hilton Group	81	15,869
Bass hotels & Resorts (4 Inter-Continental, 1 Forum, 54 Express by Holiday Inn, 19 Holiday Inn, 11 Holiday Inn Garden Court, 8 Crown Plaza	97	14,074
Thistle Hotels Mount Charlotte	56	10,718
Accor UK Ltd (20 Novotel, 8 Formule, 1, 35 Ibis, 1 Sofitel, 1 Mercure, 1 Etap)	66	7,674
Choice Hotels Europe	91	7,428
Corus and Regal Group	97	6,635
Scottish and Newcastle retail	123	6,427
Moat House Hotels	43	6,208
Macdonald Hotels	74	4,977
Millenium & Copthorne Hotels	17	4,083
De Vere Hotels & Leisure	32	4,053
Britannia Hotels	19	3,864
Imperial London Hotels	6	3,303
Premier Hotels	30	2,887
Shearings Hotels	37	2,858
Warner holidays	13	2,600
Principal hotels	14	2,233
Jurys Doyle hotel group	10	2,200
British Trust Hotels	26	2,090
Old English Inns	112	2,149
Paramount Group of Hotels	16	2,022
Radisson Edwardian Hotels	10	1,922
Starwood hotels & resorts	7	1,864
Peel hotels	25	1,781
The Grand Hotel Group	6	1,717
Marriott International	6	1,654
Hanover International	14	1,500
Groupe Envergue: Campanile Hotels	15	1,121

Name	No of hotels	Rooms
Menzies hotels	18	1,107
Marston hotels	14	1,025
Leisureplex Ltd	13	1,023
Hastings Hotels	6	780
Vienna Group	9	775
Radisson SAS hotels	3	755
The Savoy Group	5	716
Shire Inns	8	697
Chamberlain hotels	2	695
Zoffany	10	674
The Harrington Group	3	624
Brend hotels	11	611
Seymour hotels	4	606
Forestdale hotels	11	550
CG hotels	4	510

Marketing Consortia

Name	No of hotels	Rooms
Best Western	376	17,805
Les Routiers	372	12,455
The Independents Hotel Association	235	7,200
Grand Heritage hotels	100	4,730
Minotels	159	3,063
The Leading Hotels of the World	18	2,677
Small Luxury Hotels of the World	39	1,974
Pride of Britain	33	767
Relais & Chateaux	21	474
Summit Hotels & Resorts	3	460

Source: HCIMA (2001) as in Worldsmith & Company 31 October 2000

7.1.2.4 Operating statistics in the hotel sector

According to the Worldwide Hotel Industry Survey carried out by Horwath International (Travel & Tourism Intelligence, 1999), chain affiliated hotels largely outperformed independent properties around the word, in particular 67.8% against 63.6% in terms of occupancy and US$93.30 compared with US$84.28 in ADR (Table 7.1.2.4.a). This was undoubtedly explained due to the more efficient distribution systems available to chain hotels. However, the study predicted that this difference is likely to reduce as small, independent properties increasingly compete for business via the Internet that gives a more level playing field.

Table 7.1.2.4.a Occupancy and ADR in hotels around the world by operation, 1998

Operation	Occupancy (%)	ADR (US$)
Chain affiliated	67.8	93.30
Independent	63.6	84.28
World	66.7	90.89

Source: Travel & Tourism Intelligence, (1999) In the UK, there are a number of studies assessing the operating and financial performance of hotel businesses. BHA (2000) provided statistics from three reports published by Arthur Andersen, Pannell Kerr Foster (PKF) and TRI Hospitality Consulting. It should be highlighted that samples and sample sizes differ amongst studies, that surveys are based primarily on a range of year-round business hotels, predominately as part of major groups and that sample bases also change from year to year. Thus, data should be interpreted with care.

During 1995-1998, UK average occupancy levelled off (Table 7.1.2.4.b) but occupancy should not be divorced from average achieved room rate and yield, together they represent the true measure of profitability and by implication productivity.

Table 7.1.2.4.b Average room occupancy (%) in UK, 1995 - 98

	1995	1996	1997	1998
Arthur Andersen	73.8	76.5	76.5	76.1
TRI	69.6	72.5	74.3	72.9
PKF	73.5	75.9	77.5	77.1

Source: BHA (2000)

Average room rate (ARR) and revenue per available room (REVPAR) has continued to grow (Table 7.1.2.4.c).

Table 7.1.2.4.c ARR and REVPAR in UK (£), 1995- 98

	Arthur Andersen		TRI		PKF	
	ARR	*REVPAR*	*ARR*	*REVPAR*	*ARR*	*REVPAR*
1995	56.93	42.04	43.22	30.21	60.85	44.72
1996	62.95	48.15	47.02	34.27	67.69	51.86
1997	73.35	56.10	53.31	39.76	77.14	59.77
1998	78.01	59.34	55.26	40.94	81.76	63.06

Source: BHA (2000)

Room revenue as a percentage of total revenue has been increasing, while the former is higher for hotels in London than in the other regions, illustrates the higher dependence of hotels in London on rooms provision (Table 7.1.2.4.d).

Table 7.1.2.4.d Room revenue as a percentage of total revenue English, Scotland, Wales and London regions (%), 1995 - 98

	English regions				Scotland				Wales				London			
	1995	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*
TRI	44.3	45.4	49.0	46.4	44.1	45.8	47.9	48.6	36.4	47.5	46.4	42.2	46.3	47.8	51.8	49.7
PKF	45.9	49.7	49.2	50.1	44.2	46.3	48.5	49.0	42.5	45.0	45.5	46.6	52.9	54.2	56.1	56.2

Source: BHA (2000)

Thus, food revenue as a percentage of total revenue is higher in UK generally than in London. Because of higher costs attracted by the food department, this has implications for the profitability of hotels outside London (Table 7.1.2.4.e).

Table 7.1.2.4.e Food revenue as a percentage of total revenue UK and London (%), 1995- 98

	UK				London			
	1995	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*
TRI	29.3	27.9	26.0	26.1	17.7	17.2	16.0	15.1
PKF	27.5	26.7	25.3	25.2	20.1	20.8	18.7	19.3

Source: BHA (2000)

Beverage revenue as a percentage of total revenue is consistently lower in London than in the UK as a whole (Table 7.1.2.4.f).

Table 7.1.2.4.f Beverage revenue as percentage of total revenue UK and London (%), 1995- 98

	UK				London			
	1995	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*
TRI	12.1	11.9	11.1	12.0	6.1	6.0	5.6	5.3
PKF	10.4	9.8	9.8	9.6	12.7	7.5	6.9	7.0

Source: BHA (2000)

As turnover has increased throughout the period, the percentage of total payroll to total revenue has fallen (Table 7.1.2.4.g). This highlights the productivity and profitability efficiency of the industry, particularly London.

Table 7.1.2.4.g Percentage of total payroll to total revenue UK and London (%), 1995- 98

	UK				London			
	1995	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*
TRI	28.7	27.2	23.7	24.5	24.5	24.5	20.6	20.6
PKF	28.4	26.6	26.9	26.2	27.7	25.6	25.5	23.7

Source: BHA (2000)

Gross operating profit has risen substantially during the period, with the greatest rise recorded in London (Table 7.1.2.4.h). The substantial differences between the two sets of data are probably due to sampling.

Table 7.1.2.4.h Gross operating profit per available room UK (£'000s), 1995-98

	TRI				PKF			
	1995	*1996*	*1997*	*1998*	*1995*	*1996*	*1997*	*1998*
UK	8.28	9.34	11.05	12.63	11.38	13.75	16.23	17.80
London	12.15	15.09	17.15	19.22	17.99	21.13	25.81	27.59
Regional England	7.74	8.72	10.30	11.80	8.62	10.47	12.19	13.88
Scotland	8.20	9.11	10.50	10.39	9.23	11.42	12.15	13.25
Wales	5.34	7.22	7.74	12.19	7.30	10.84	10.68	12.69

Source: BHA (2000)

7.2 The importance of ICT in the Tourism and Hospitality

The tourism and hospitality sectors have a number of characteristics, which mean that the development of ICT present some major opportunities. Key characteristics of the sectors are that there are great or even worldwide space and time differences between the demand and supply, the supply is highly perishable and consists of a great variety of products that cannot normally be inspected, seen or felt in advance. Thus, advance reservations and information as well as organised and planned co-operation and collaboration between the different tourism and hospitality suppliers are indispensable operational activities for businesses. The development of global distribution systems, computerised reservation systems and more recently, virtual reality and e-commerce platforms all bear witness to the way in which tourism and hospitality organisations have taken up the new technologies in order to make their operations more efficient and effective. As Buhalis (1997) suggested:

"information technology will be instrumental in the industries' ability to enhance their future efficiency and strategic competitiveness"

Overall, the tourism and hospitality sectors would seem to be an ideal area for the application of ICT, because of their following characteristics and features:

- tourism and hospitality are a *complex product,* involving the integration of services from diverse organisations: private and public, large and small, local and remote;
- effective *collaboration* between these organisations is essential for the delivery of a quality product. Moreover, distance between consumers and suppliers means that *partnership* with local expertise and network is essential;
- the availability of *up-to date, accurate and accessible* information is regarded as crucial for the success of a tourist product;
- it is *information* rather than the physical product that needs to be *distributed* and made available to both intermediaries and end consumers. As Poon (1988, p.533) claimed:

"Unlike consumer and industrial goods, the essential intangible tourism service cannot be physically displayed or inspected at the point of sale. It is normally purchased well in advance of the time and away from the place of consumption. In the marketplace, therefore, tourism is almost completely dependent on representations and descriptions in printed and audio-visual forms."

McKinsey's (1996) report claimed that the importance of the new interactive and digital media for tourism and hospitality is underlined by relating the fit of interactive media with their potential for relationship marketing. Figure 7.2.a illustrates that because of their features travel services, as financial, are the best-fitted services among those of all industries for the use of interactive media in building and maintaining relationships.

Figure 7.2.a Categories suitable for digital marketing

Fit with Interactive Media	Low potential for Relation Marketing	High potential for Relation Marketing
High	News; Software; Selected Groceries; Interactive Games	Insurance; Travel services; Music; Books; Financial services; Real estate; Brokerage
Low	Sporting goods; Convenience stores; Gasoline	Toys; Autos; White Goods; Medical services; Consumer electronics products; High-end apparel

Low   Low   Potential for Relation Marketing   High

Source: McKinsey (1996)

However, the service element of the tourism and hospitality product also implies the need for integrating the customers into the production process (Sheldon, 1997) and so, the impact of ICT in tourism and hospitality is not restricted to marketing but includes production operations as well. This is illustrated in Figure 7.2.b that plots industries based on the impact of IT on their marketing and production processes. Because of the high involvement of the customer in the production process, i.e. the service encounter, hotels and other travel and tourism industries account for the highest ICT impact in their production and marketing processes.

Figure 7.2.b IT impacts on different industries

IT impact on Production	Low IT impact on Marketing	High IT impact on Marketing
High	Defence; **Logistics**	Software; Electronics; Airlines; Banks; Tour operators; Travel agents; Hotels; **Strategic**
Low	Paper; Lumber; **Support**	Retailing; High fashion; **Marketing**

Low   Low   IT impact on Marketing   High

Source: Sheldon, (1997)

The impact of ICT on marketing implies enhanced organisational capabilities to react faster to changes in the external environment, to improve product differentiation and provide increased and enhanced accessibility to customers. The impact of ICT on production reflects enhanced capabilities to cope with complexity, to integrate better and coordinate internal operations while reducing costs. Thus, tourism and hospitality sectors lie in the strategic corner of Table 7.2.b implying the interwoven relationship between ICT and both internal and external operations (McKenney, 1995). Figure 7.2.c also provides examples of ICT applications from the tourism and hospitality industry in all four classification cells.

Figure 7.2.c Classification of ICT applications depending on marketing and operational impact

IT impact on Production		
High	**Logistics:** scheduling systems	**Strategic:** integrated reservation and booking systems, yield management systems
Low	**Support**: operational support systems	**Marketing:** database marketing
	Low — IT impact on Marketing	High

Source: McKenney (1995)

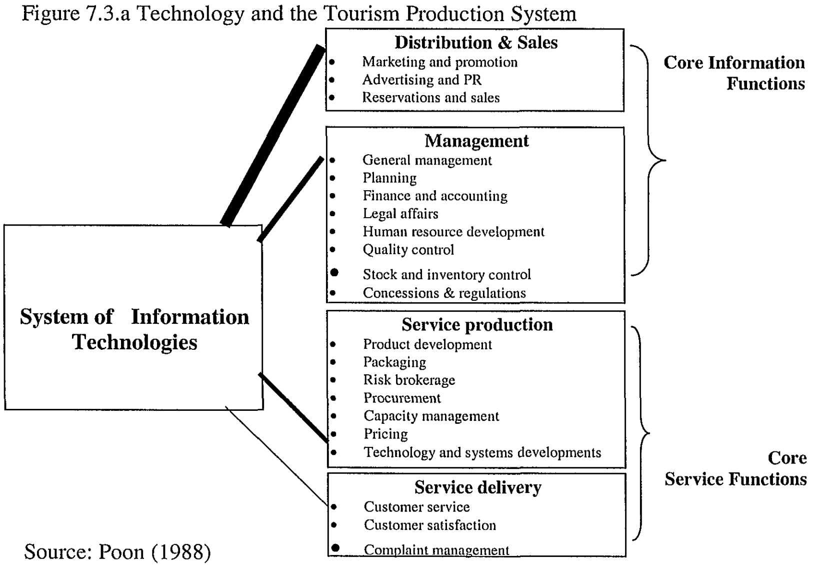
The varied and specific application of ICT in tourism and hospitality has been analysed and modelled by two frameworks. These are analysed and commented on the following.

7.3 Frameworks modelling ICT applications in tourism and hospitality

A useful tool for understanding the diffusion and application of the ICT in tourism was developed by Poon (1988). She claimed that tourism suppliers possess dual production systems, because they comprise *services* and *information.* So, suppliers provide the services of hotel bed-nights, airline seats and package tours but they also have to produce and distribute information about price, special promotions, location, availability etc. In this vein, Poon (1988) proposed a dual (service and information) Tourism Production System (TPS) of tourism producers that is simplified into four categories namely, service production, management, distribution and sales and service delivery (Figure 7.3.a). Although it is very difficult to differentiate between these four categories, since the TPS is a very integrated process, the identification of the TPS and its subdivision into four parts was argued to provide a very useful tool for understanding the diffusion and impacts of the ICT in tourism.

Poon (1988, p.178) argued that *"ICT will have their greatest impact on the information-intensive areas of tourism production and lesser impact on the service and labour intensive areas"* and indicated the intensity of the impact by the boldness of the lines in the TPS model. The area of marketing and distribution will receive the greatest impact of ICT followed by management, services production and finally, service delivery. Thus, according to Poon (1988, p. 179), ICT will diffuse very unevenly through the four elements of the TPS and *"...the imperatives of distribution of travel and tourism services will dictate the pace of technology adoption".* However, although this may have been traditionally the case with early ICT applications e.g. promotion and distribution, nowadays, ICT are increasingly being used for core production/service functions, e.g. self-service kiosks, use of ICT for personalising products and services and computer based training.

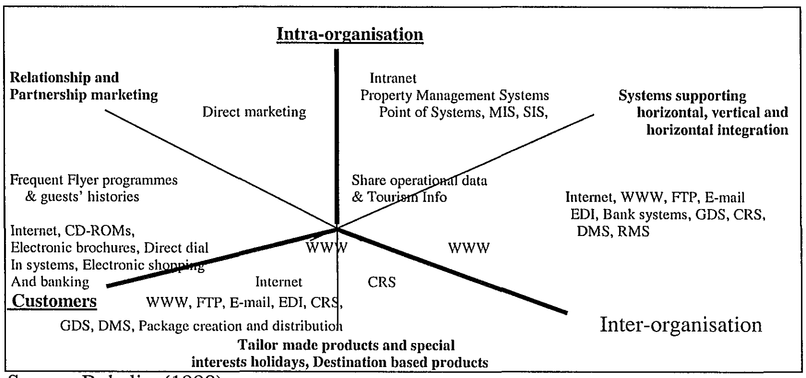
Figure 7.3.a Technology and the Tourism Production System



Source: Poon (1988)

Buhalis (1998) also developed a framework of the strategic use of ICT in tourism that identifies both the business functions and technologies applied (Figure 7.3.b).

Figure 7.3.b Tourism and Information Technologies strategic framework



Source: Buhalis, (1998)

Within the hospitality sector specifically, participants of the IH&RA Technology Think Tank (IHRA, 1999) also argued that ICT are becoming pervasive, affecting all hotel operations and processes and so creating a greater impact on the organisation. Think Tank participants also advocated that as ICT play a boundary-spanning role within the hotel business and it increasingly becomes difficult, if not impossible, to separate technology decisions from hotel business decisions. In this vein, ICT must enjoy the same level of consideration and status in a hospitality organisation as any other core management discipline, if ICT's potential is to be fully realised. Hence, ICT decisions should not anymore be relegated down the ranks of the corporate hierarchy and delegated to a set of individuals who may be isolated from key hotels' initiatives, but rather hotels need to elevate a number of technology positions in the executive ranks (IHRA, 1999). In some organisations, a number of new positions (e.g. chief information officer, chief web officer) have been added demonstrating businesses' commitment to create a high tech infrastructure and foster ICT initiatives.

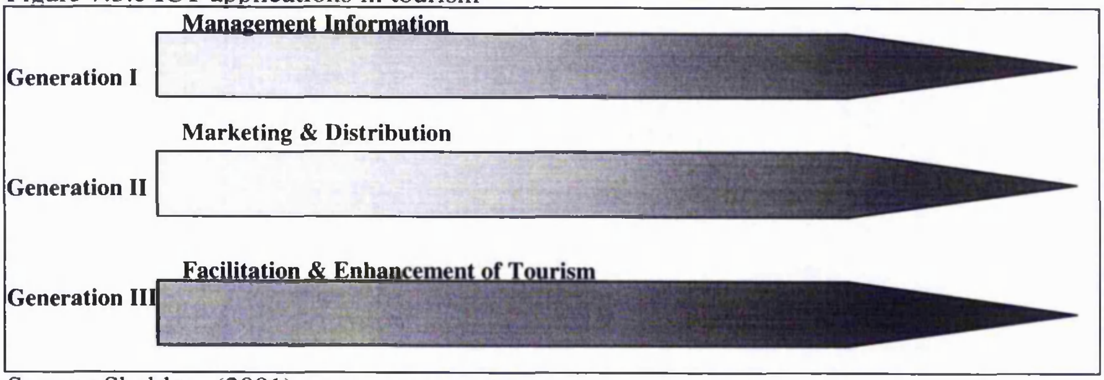
In a digital economy, ICT bring about fast-paced, continuous and radical changes within the hospitality industry, many of which can be seen in the fundamental structure of the industry, the methods of interaction and shifts in the balance of power between buyers and sellers, the pricing and distribution models used to sell products and services, operating systems and processes and generally in the way hospitality firms conduct day-to-day business. In this vein, the impact of ICT stretches across the entire hospitality enterprise and it is becoming an increasing important component of management decisions.

The sum and the substance of these models is that technological developments and their applications are rapidly diffusing within tourism and hospitality businesses as well as along the entire industry system affecting all types of operations. No task or job can escape from ICT and the delivery of every activity is directly or indirectly affected by the deployment of ICT. Moreover, it is made evident that ICT facilitating and enhancing team and group working, staff communication and knowledge sharing (e.g. Intranets, Internet, groupware software) are increasingly becoming important business applications. ICTs increase an organisation's ability to co-ordinate activities regionally, nationally and globally while unlocking the power of broader geographical scope to create competitive advantage (Porter and Miller, 1985) and they also facilitate the globalisation of the industry.

However, these models fail clearly to illustrate the shift in ICT applications that are mainly driven by the integration and communication features of ICT. That is that ICT applications are nowadays immigrating from automating local and specific work tasks towards integrating and linking different business activities into a streamlined process. For example, ICT applications such as E-procurement, Supply Chain Management and Customer Relationship Management that integrate several and traditionally separate business functions now enable and foster flexible working, multi-skilling, downsizing and other operational efficiencies. Moreover, previous models are also limited in their capability to illustrate effectively and clearly how advances in the "information" element of ICT foster and enable enhanced ICT exploitation and applications. This latter issue is more clearly illustrated in Sheldon's (2001) model of ICT applications in tourism.

Sheldon (2001) identified three generations of ICT applications in tourism as well as analysed their evolution due to technological advances (Figure 7.3.c). The three ICT generations namely management information, marketing and distribution and later facilitation and enhancement of tourism partly reflect Poon's (1988) earlier arguments that the diffusion and application of ICT has been driven by marketing and management use of information, while the impact of ICT on production processes has been limited. Sheldon's three generations of ICT applications also relate to the ICT development stages discussed in chapter five (i.e. data, network and information era) as well as the models of ICT applications also discussed in chapter two (see for example Zuboff's arguments). Specifically, Sheldon's three ICT application generations are: a) the evolution of management information applications from use of simple databases and statistical analysis of data (e.g. yield management systems, to knowledge warehouses and expert systems); b) the evolution of marketing & distribution applications from simple informational and transactional computer reservation systems to channels enabling personalised, one-to-one marketing and customer decision making (e.g. agents); and c) the evolution of facilitation and enhancement of tourism applications from simple destination information systems and static kiosks to intelligent and ubiquitous, mobile accessible devices illustrate the innovative ICT applications enabled by advances in the "information", "communication" and "convergence" (of media, content, telecommunications, hardware, software) features of ICT. Specifically, Sheldon (2001, p. 10) argued that increasingly *"...the worlds of high tech and high touch can merge to create synergies that will bring the tourism industry into the new economy"*.

Figure 7.3.c ICT applications in tourism



Source: Sheldon, (2001)

It is however evident that ICT are an imperative and indispensable partner of the tourism and hospitality industry and that they increasingly play a more important role in all operations within the value chain and industry system. Vlitos-Rowe (in Buhalis, 1999, p.2) explained that ICTs are *"...having a dramatic impact on the travel industry because they force this sector as a whole to rethink the way in which it organises its business, its values or norms of behaviour and the way in which it educates its workforce"*. Indeed, ICT applications provide significant advantages in tactical, operational and strategic management practices. Essentially, as is widely claimed (e.g. Poon, 1988; Sigala et al, 2000a) a whole system of ICT is being rapidly diffused throughout the tourism industry and no player can escape its impacts.

Poon (1988, p. 161) identified four key impacts of the diffusion of ICT in the tourism:

- it will improve the efficiency of production;
- it will improve the quality of services provided to consumers;
- it will lead to the generation of new services;
- it will engineer the spread of a whole new industry "best practice".

Buhalis (1999b) also summarised the major ICT impacts by arguing that ICT:

- enable operators to become more flexible, quicker, more efficient in response to consumer requirements and to provide better quality of differentiated products;
- change best operational practices by re-engineering new and innovative practices;
- facilitate the expansion of the industry in both geographical and operational terms;
- revolutionalise the interaction with consumers and boost customer loyalty and create seamless and unique experiences through partnerships with other suppliers;
- facilitate the management, promotion and distribution of destinations and businesses to an electronic marketplace.

7.4 ICT applications in the hotel sector

7.4.1 Introduction: the objectives and development of an electronic hotel infrastructure

According to Kasavana (1982) there are four major objectives for developing a computerised hotel management information infrastructure:

- present management with timely and comprehensive reports;
- eliminate or reduce the number of unnecessary source documents;
- provide increased operational control;
- enable management to better monitor the guest cycle.

The guest cycle identifies the physical contacts and financial exchanges that occur between guests and various revenues centres within a lodging operation. From a practical point of view, the guest cycle serves as a clarification of an intricate series of communications within the hotel network and is defined as the period of time from when a potential customer first contacts the hotel through to checkout and reconciliation of account (Bardi in Khan et al, 1993). The traditional hotel guest cycle was based on interactions in terms of a sequence beginning with the arrival of a guest, continuing through the guest's occupancy and ending with the guest departure (Figure 7.4.1.a). Many hotels have revised the latter into a sequence of phases beginning with presale events, point-of-sales activities and concluding with post-sale transactions.

Figure 7.4.1.a The Guest cycle

PRE-SALE →	**POINT-OF-SALE** →	**POST-SALE**
Reservations	assignment of room	statement of Guest account
Prepayment	occupancy	reconciliation of account
Initialisation of guest Account	purchasing of goods/services	Zeroing out balances
Arrival	charges posted to guest account	checkout
Registration		

The concept of guest cycle has been adopted for the following reasons:

- it provides a step by step analysis of how customers are processed and so it identifies areas whereby ICT can be applied;
- it makes a clear distinction between the information and customer processing activities.

Kasavana (1982) described the functionality of ICT applications supporting the guest cycle as follows. First, reservation systems carry out the following functions:

- Guest information collection
- Preparation of a guest or master folio
- Generation of registration cards
- Initialisation of room rack slips
- Production of arrival and departures lists
- Room availability reports
- Ability to block out groups of rooms
- Automatic room assignments
- Printed letters of confirmation
- Establishment of a guest account and record of pre-payments
- Generation of forecast occupancy report

As soon as the guest arrives, ICT applications are required in order to support the room management functions. These systems track the status of the rooms and assist different department with their duties as well as support their interdependent tasks, e.g. housekeeping department with preparing rooms, the front office for allocating customers to rooms and the reservation staff for selling room capacity. Typical room statuses are: occupied, vacant, dirty, clean, inspected, un-inspected. The room status changes in every check-in, check-out and so, the dissemination of updated information is crucially important so that rooms can be sold as soon as they become available. Required rooms management functionality includes (Kasavana, 1982):

- Production of room status reports
- Sales forecasting/marketing reports
- Occupancy reports (analysed by type)
- General housekeeping reports
- Evaluation of housekeeper's productivity and maids scheduling
- Overall maintenance analysis
- Engineering department reporting

The guest accounting created by guests' transactions during their stay is made more efficient with ICT. This application brings the guest's reservation file into an active in-house file and a guest folio is opened. If a guest does not have a reservation prior arrival then a file is created at the time of the check-in, as most PMS have a walk in option. Interfaces between PMS and card verification systems in banks are used in order to ensure adequate funds for the length of stay of the guest. The functionality of a guest accounting system is summarised as follows (Kasavana, 1982):

- Construction of electronic folios
- Capability to assign more than one folio per room
- Immediate department posting automatically
- Instant access to any guest folio without physical handling
- Assignment of guest credit limits to each folio
- Required credit and guest verification prior to accepting charges for posting
- Production of itemised guests statements
- Automated night audit (trial balances of all accounts)
- Late charges automatically transferred to the city ledger for billing
- General ledger accounting

The digitisation of all hotel functions provides management with a wealth of real-time information to better understand their operations, assist them with decision making and take the appropriate correction actions. Insight into critical statistics (e.g. occupancy rates, ARR, gross operating profit etc) can give management a better sense of control over their operations and more power to make decisions. ICT applications can generate many standard reports through a report generator, which prints specialised, ad hoc reports from the variables in the database as needed. Kasavana (1982) gave a list of ICT management functions:

- Generation of analytical reports (i.e. occupancy, status, budgets etc);
- Cost centre reports (i.e. food, labour etc);
- Construction of sales reports (i.e. room, food etc)
- Control reports (i.e. inventory, housekeeping etc);
- Corporate/financial/accounting reports and statements;
- Security systems provisions

The challenge nowadays is to filter and manipulate of the vast amount of information collected for supporting effective decision-making. Thus, Executive Information System (EIS) and Decision Support Systems (DSS) are being integrated with other ICT applications in order to extrapolate and analyse information. However, Cline and Warner's (1999) findings revealed that although a great majority of hotels have achieved an interface between their management systems and the Property Management System (PMS), this percentage is substantially lower when integration issues are analysed at the hotel property level (Table 7.4.1.a).

Table 7.4.1.a Management systems integrated with PMS

	Total		**Parent headquarters**		**Regional headquarters**		**Headquarters total**		**Hotel**	
	Now	2000	Now	2000	Now	2000	Now	2000	Now	2000
Yes	64	64	74	63	69	72	73	67	55	46
No	28	28	23	29	19	16	22	31	33	46
Don' t know	9	8	4	8	13	12	5	3	11	8
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Cline and Warner (1999)

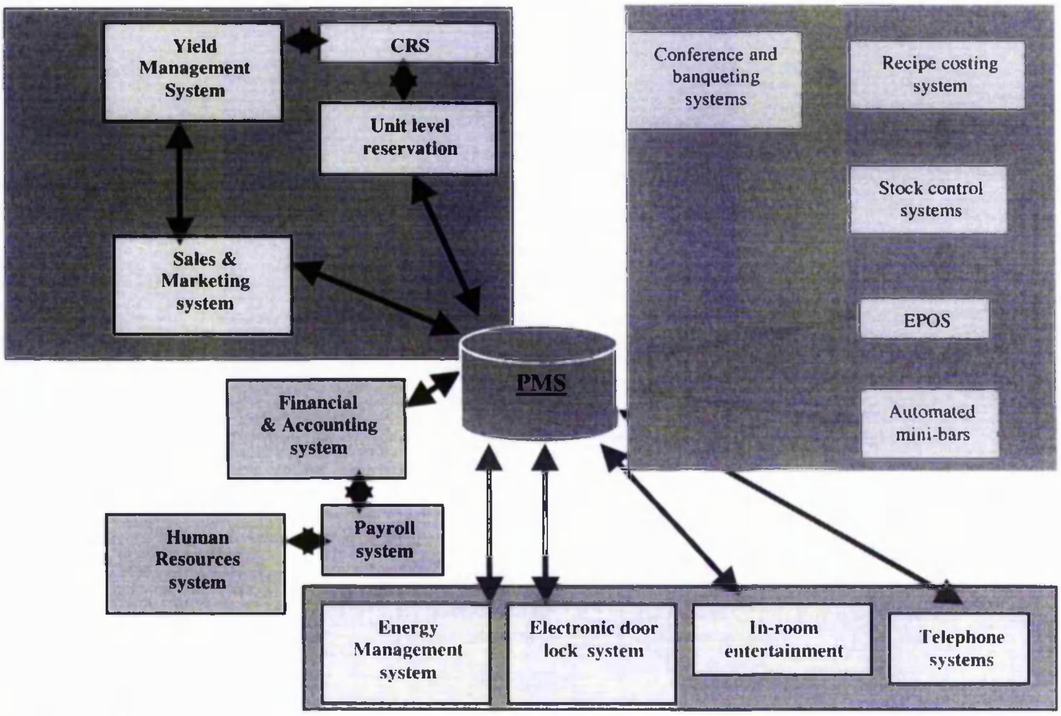
Numerous ICT applications (Table 7.4.1.b) exists to support the guest cycle functions. However, O'Connor (2001) gave a more detailed model of the configuration and architecture of ICT applications in an hotel property (Figure 7.4.1.b).

Table 7.4.1.b ICT systems in hotels

Reservations	***Call Accounting***
Room availability, Confirmation	Guest information, Call posting
Front desk	***Accounting***
Check in, Room status, Postings to guest bills, Guest credit audit, Advance deposits, Cashier, check-out	Accounts payable and receivable, General ledger, Payroll, Profit & Loss statement, Balance sheet
Housekeeping	***Maintenance***
Room status	Work orders
Marketing and Sales	***Food and Beverage***
Client file, Direct mail, Guest history Travel agent	Point of sale, Menu analysis, Inventory Recipes
Night audit	***Human Resource Management***
Room and tax posting Various operational reports	Personnel files, Time and attendance
Electronic mail	***Security***

Source: Bardi, (1990)

Figure 7.4.1.b The ICT hotel infrastructure



Source: O'Connor, 2001

ICT applications are clustered together depending on the hotel department in which they are found. The top left cluster represent ICT applications in rooms division, the top right cluster represent ICT applications in the Food and Beverage division, while the bottom cluster represents ICT applications that have a direct impact on guests services and amenities. Financial and accounting systems, payroll systems and human resource systems cannot be devoted to a particular hotel department, since they support functions within the whole hotel property. The arrows in the figure represent integration between ICT applications. ICT interfaces are important because of the interdependence between hotel departments and the need for communication and task coordination among different staff.

At the centre of the hotel electronic infrastructure is the hotel's core system, i.e. the Property Management System (PMS). According to Sheldon (1997) the PMS is the central computer which handles the core functions of a hotel's information processing including reservations, front office operations, back office operations and management functions, in addition to being the hub for all interconnectivity with other systems in the hotel. In other words, the PMS is the digital nervous system as described by Gates (1999) or according to Kasavana (1987) the PMS serves the host in a multiprocessor environment that involves interfacing computer processors enabling them to share data, peripheral devices and operating systems. Thus, the PMS is the electronic platform that by accessing data from different integrated ICT applications can provide a consolidated information database and central point for monitoring and controlling several front and back office functions.

Hotels usually implement their PMS on an in-house IT department to support it, but out of the box PMS solutions are also offered by IT vendors, which are a more economic option for small and independent properties. There has been a debate on whether hotels should develop proprietary systems or buy "out-of-the-box" solutions. Although this might be a crucial point as customisation to the property's particular needs and organisational configurations might be required, ultimately it should not be overstated. This is because it is not the hardware or even the software that delivers the business benefits or as Cline (1996) argued what actually drives value is how ICT are being applied and what management does with the information when it gets it.

However, systems' integration has never been easy and/or possible as an ideal electronic hotel infrastructure would mandate. The following section analyses the issues and trends regarding systems integration as well as the benefits and applications that hotels can derive by integrating their ICT applications.

7.4.2 ICT integration issues and implications

Integration issues between ICT systems in a hotel electronic environment were quite early argued by Jones (1985), whereby he envisaged that systems' integrations can enable hotel properties to immigrate from the clerical computer to the tactical and more strategic computer applications. The major reason and benefit derived from systems integration is the synergy effects that accrue. Synergy refers to the enhanced value of each system brought about through interfacing. According to Kasavana (1987) interfacing creates a whole (multiprocessor environment) which is perceived to be greater than the sum of its individual parts (independent, stand alone computer system) and he provided the following example to illustrate that. Specifically, traditional hotel posting procedures were compared with the synergetic value gained through an effective EPOS/PMS interface. A front office employee, working without an EPOS/PMS interface, must manually post restaurant charge vouchers to folio accounts. This process requires the front desk employee to sort the vouchers, retrieve the appropriate folios, post the charges and refile the folios. By contrast, the EPOS/PMS interface allows the restaurant charges to be electronically transmitted from EPOS to the PMS guest accounting module. Charges are posted to the proper folios without the intervention of a front office employee. In other words, systems integration aims at eliminating bottlenecks and smoothening the flow of resources within disparate hotel processes, as Schmenner and Swift (1998) would argue.

Systems that cannot communicate not only slow down hotels' operations but they also create "islands of information" that can be accessible only from certain staff. However, information accessibility can considerably affect customer service and satisfaction because such isolated systems inhibit hotel staff to answer guests questions immediately and without referring to other departments as well as to provide more customised personal service. Thus, apart from the tangible benefits, systems integration also fosters intangible benefits such as improved guest service, more efficient clerical procedures and higher employee morale.

A survey of 300 hotel managers in U.S. conducted by Honeywell Inc (Braham, 1988, p. 272) showed that three out of five hotels did not have an integrated system, but most managers thought that installation would be inevitable in the future. An integrated system was defined as "*one that integrates a hotel's computers, communications and controls' and included property management, energy* *management, automatic temperature control, telecommunications and fire safety systems".* The most important reasons for integration stated by hotel managers were the following: improved service, productivity improvements, guests' comfort and cost savings. The international study of Cline and Warner (1999) on hospitality technology also revealed that 82% of hotel managers believed that hotels systems that do not talk to each other has had a negative financial impact.

On the other hand, several business drivers mandate the integration of ICT applications. These are: supply chain optimisation; e-commerce and online transactions; Customer Relationship Management applications; accurate information access to call centres and the provision of customer care; customer and employee self-service applications; mass customisation practices (e.g. customer identification on Internet); one-to-one marketing; business process improvement and reduced business change cycle-time; acquisitions and mergers, (it has been reported that in some cases systems incompatibility has even inhibited mergers and acquisitions of properties within hotel groups, Bennett, 1999); the development of the virtual hotel organisation through the outsourcing of services through Application Service Providers; direct access to customers and the dis-intermediation of the distribution chain; real time access to quality information and integrity of data.

There is a wide diversity of support systems that need to be used by hotels. The problem is that there are very few software suppliers that can deliver an all embracing and fully integrated solution to a hotel's automation needs. While one software company may be particularly strong on core PMS systems, its food and beverage package may be weak. As a result, hotels are forced to go to different software suppliers for different applications. However, this led on to the problem of standardisation when hotel management wish to automate, since in the area of hotel automation, there is very little compatibility between subsystems supplied by different software companies.

Thus, traditionally, technology offerings tend to be architected for a single function (i.e. point-of-sale, F&B, security etc) and mostly for a single hotel. Often these systems operate on multiple hardware and software platforms offered by a wide variety of IT vendors. Consequently, the today's hospitality industry technology represents a legacy reflecting the computer industry's capabilities during the last two decades and the willingness of hotel executives to embrace its products in a piecemeal approach (Cline, 1996). In particular, Cline (1996) contributed the problem of hotel systems integration to:

- the ICT vendors that for long only addressed individual parts of the industry's real needs with little regard to total systems solution;
- the piecemeal ICT investments from the hotel sector, that used to select vendors on the basis who makes the best;
- more importantly, the failure of the industry to cooperate in the development of shared technologies and industry common standards.

Specifically, initiatives undertaken for overcoming the systems' integration problems can be clustered into three categories namely interfaces with hotel internal systems, with third party systems and integration through Enterprise Resource Planning (ERP).

Three major initiatives aiming at integrating ICT systems internal of a hotel property have been undertaken (Cline and Warner, 1999, p. 19). First, the Integrating Technology Consortium (ITC), an organisation of interested hotel companies and vendors, whose major concept was designed around a piece of middle-ware (a router) that would allow the interfacing of different systems. The ITC initiative was a powerful one, but it failed to establish itself successfully. Second, the short lived WHIS Initiative (Windows Hospitality Interface Standards) aiming at developing interfacing standards and the currently existing Hospitality Industry Technology Integration Standards (HITIS) movement, which adopted a "best practice" approach to developing the standards.

Interfacing requirements of hotel ICT applications with third parties refer mainly to integration with the Global Distribution Systems initially developed by airlines. Two major players are found in the market providing such functionality namely THISCO or nowadays Pegasus and WizCom. However, nowadays, several other Internet based companies provide different solutions for distributing hotels in airline GDS, such as Worldres.com, all-hotels.com etc.

Nowadays, integration problems between multiple hardware platforms and software applications are being addressed by ERP and the development of enterprise-wide data warehouses. The major role of ERP is to extract, transform, clean and load data from source systems into specially designed, separate repositories for wider, seamless and real time information processing, accessibility and dissemination. According to Cadbury (16/2/2000) hotels' enterprise-wide data warehouse should integrate, store and disseminate data from three types of systems: a) transactional systems, e.g. PMS, EPOS, CRS, Financial and Yield Management systems; b) other internal information, e.g. budget information, wage analysis, marketing activities tracking, web site click analysis; and c) external information systems, e.g. demographic, lifestyle data, benchmark information, purchased marketing lists, behavioural and attitudinal profiles. Briefly, ERP aims at automating repetitive processes and providing managers with a more comprehensive, consistent and timely view of their business as well as a "plug and play" infrastructure for future applications. Moreover, benefits of ERP and enterprise wide data warehouse span all hotel operations and all levels of management and are summarised in Table 7.4.2.a.

Table 7.4.2.a ERP and Enterprise Wide Data Warehousing benefits

Business Area	Focus	Initiatives
Front office / sales and marketing	Customer	*Customer Relationship Management* Campaign/channel effectiveness, Customer Chain analysis, Customer retention & profitability etc.
Management	Organisation	*Enterprise Performance Measurement* Activity based costing, Benchmarking, Consolidation etc
Back office operations	Resources	*Enterprise Resource Management (ERM)* Workflow optimisation and utilisation, Compensation planning, Supplier management Promotion planning, Sales forecasting etc.

Source: Gadbury, 16/2/2000

Unfortunately, data from the international survey of hotel technology (Cline and Warner, 1999) revealed that only a very few hotels (9%) claimed to have implemented ERP. Overall, hotels nowadays stand at the latest wave of a historical evolution beginning with the early hotel accounting systems in 1960s and late 1970s, followed by a variety of front office systems introduced in the 1980s and finally to today's PMS and the latest efforts in integrating customer information systems, data warehouses or developing an ERP platform. Cline (1996) predicted that the next breakthrough in hospitality technology will occur when the PMS is dislodged from its place at the centre of hotel computer systems. Actually, the integration of property management, central reservations, data warehouse and distributed databases is leading several large chains (e.g. Carlson) a fully integrated system that brings customer, statistical and financial information together and creates new structures and cultures.

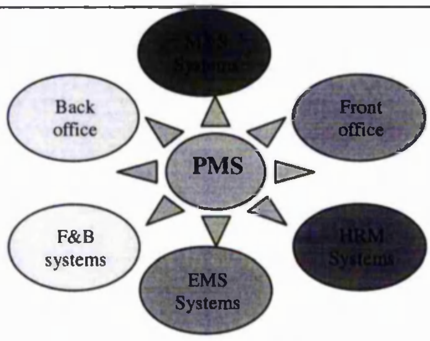
Perhaps, the electronic infrastructure of the hotel of the future would be the one that would immigrate from the traditional ICT architecture that reflects and supports the conventional functional/departmental based hotel organisational structure to the customer oriented ICT architecture that would enable and foster a customer centred hotel structure and culture (Figure 7.4.2.a). It that case, an enterprise wide customer database would replace the central role of the PMS by being the hub and the digital nervous systems of all hotel ICT applications, while the hotel ICT systems would be reconfigured and structured around customer databases and mining systems.

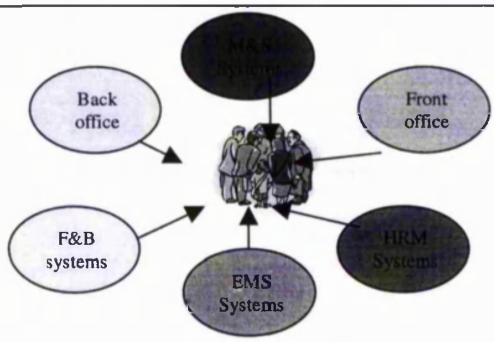
The need for such ICT reconfiguration has been driven and fostered by the e-business evolution whereby hotels are trying to webify (i.e. immigrate on Internet technologies) all their operations. Webification of hotel business means that hotels make their operations accessible 365x7x24 hours through any Internet enabled device, which in turn entails the management of multiple customer touch points. Ultimately, data warehousing and mining technologies will ultimately be required to link/integrate and synchronise all these touch points. The diminishing importance of PMS in conducting e-business was recognised by Cline (2000, p. 5), who advocated that *"in the e-business environment the property management system will no longer hold sway as the center of the hospitality universe, but will become just one in a series of customer touch-points that will increasingly include the Internet".*

Such a hotel infrastructure (both ICT and organisational) as well as hotel culture are also becoming crucially important because of the increasing power and significance of customers in the hospitality sector. Moreover, a customer focused ICT and organisational infrastructure can further foster and enable multi-skilling and flexible working within hotel properties, whereby hotel staff can be directed and moved to serve customer needs and fill service gaps wherever and whenever is required. Such practices require substantial hotel staff reskilling, retooling and training initiatives but they can lead to tremendous operational efficiencies and organisational effectiveness.

Figure 7.4.2.a The customer focused hotel ICT architecture

Now The functional oriented hotel	**Future** The customer centred hotel
see below	see below





7.4.3 Analysis of ICT applications in the hotel sector

The central role of the PMS in the computerised hotel environment as well as the increasing importance of the customer database for the ICT architecture have been analysed. The aim of the following section is systematically to analyse and discuss other hotel ICT applications by highlighting how the two major ICT elements namely integration and information (as discussed in chapter five) can significantly enable innovative uses of ICT applications and so affect the type and amount of ICT benefits.

7.4.3.1 Property based reservation system

A property based reservation system handles reservations at the property level. The primary reason for making use of computers in the handling of reservations is to increase room occupancy rates, but the achievement of this aim entirely depends on the level of systems integration of individual properties (Braham, 1988). This is because reservations systems do not only tremendously help in processing reservations, but they also support decision making in marketing and sales (e.g. yield management, discounts etc), the creation a guest record etc. Several other authors argued that integration between reservation systems and distribution channels can improve efficiency, facilitate control, reduce personnel and enable more rapid response time to both customers and management requests whilst enabling personalised service and relationship marketing (O' Connor, 1995; Peacock, 1995; Robledo, 1999; Sheldon, 1997; Chervenak, 1991 and 1993; Braham, 1988). Overall, most reservation systems tend to share a number of goals while serving several business functions as follows (Buhalis, 2000b, p. 46):

- Improved capacity management and operations efficiency;
- Facilitate central room inventory control;
- Provide last room availability information;
- Offer yield management capability;
- Provide better databases access for management purposes;
- Enable extensive marketing, sales and operational reports;
- Facilitate marketing research and planning;
- Travel agency tracking and commission payment;
- Tracking of frequent flyers and repeat hotel guests;
- Direct marketing and personalised service for repeat hotel guests;
- Enhance handling of group bookings.

Braham (1988) briefly outlined the requirements and benefits of a computerised reservation system (Figure 7.4.3.1.a).

Figure 7.4.3.1.a Essential reservation facilities and functions

Flexible inventory of at least 20 different room types, Unlimited future availability, Unlimited booking capability, Immediate availability update, Immediate rooms inventory update, Overbooking (oversell) capability, Complete and detail reservations screen, Individual and group reservations, Individual and group blocking, Group master records, summary and detail, Company information entry, Travel agency information entry, Travel agency activity reports, Computer assisted travel agency commission handling, Guest information enquiry, Reservations linked to city ledger, Strong guarantee parameters, Advance deposit posting and auditing, Advance deposit journal, Request for deposit and deposit received, Confirmations, plus printing of confirmation forms, Modifications and cancellation confirmations, Free-form comments field on all reservations, Services field on all reservations, System generated confirmation numbers on all reservations, User identification entered on all transaction screens, Confirmations printed automatically or on demand, Forecast reports, current and future dates to five years historical information, Detailed inventory control, No-shows reports, Computer assisted no-show handling (charging and billing), Guest information – past, present, future – retained in system

Source: Braham, (1988)

By making use of a set of online computer files, reservation records may be stored centrally with a great degree of accuracy and compared with manual systems, they can significantly reduce staff effort. Computer systems can hold thousands of reservations and find any one of them within a fraction of a second. Any system can automatically sort and update these reservations records and files. Confirmations are printed on high-speed line printers and/or faxed through automatically. Advance deposit requests are simplified and a good system may even generate personalised deposit requests. Control and communication of deposit information is made fast and simple by using a computerised centralised database.

The computer should in effect be a practical tool complementing the work of the reception staff by eliminating much of the paper work that is both time consuming and prone to errors. Details of individuals and groups are readily accessible both for reference and alternation, and it is possible for mistaken cancellations to be re-activated by the computer. Confirmation slips can be printed automatically thus saving an enormous amount of secretarial time. Group affairs are complicated affairs with a variety of arrivals and departures dates, room types and rates, but a good computer system is able to accommodate these with ease. Computerised reservations systems provide daily availability reports both in tabular and graph form either on-screen or as a print-out, whilst statistics of a more specific nature can be obtained on such items as occupancy and rooms status. A good system also simplifies complicated administrative tasks such as recording deposits by handling them automatically. This is because the system can store details along with information in diary form as to when the balance of payment is due.

Overall, a computerised system provides many benefits that were not possible with manual systems, e.g. staff can respond more swiftly to requests for accommodation as well as handle reservations for longer periods after several years. So, instead of the complex system of charts once in place in hotels, staff can now have an instantaneous picture of the exact booking situation on any given date and so deal with customers' inquires more quickly and accurately.

Braham (1988) analysed the levels of integration at which hotels can exploit computerised reservation systems and the benefits that integration derive as follows:

- *Integration with external reservations networks*, e.g. airline Global Distribution Systems, partners' corporate reservation systems. Traditionally, third party reservation systems operated by obtaining guaranteed allocations of rooms from hotels in advance that could then be sold via computer directly to travel agents and the public. However, room allocation does not allow the sale of the last available room. In order to achieve the latter and optimise occupancy rates, seamless integration between hotel reservation systems and external reservation systems is required so that a real time and accurate single image room and rate inventory can be available to all systems at any time.
- *In-house reservations networks*; a recent trend for hotel chains is to integrate their Central Reservation System (CRS) provided by the hotel chain with each property's PMS reservation system into a system called an Integrated Property System (IPS). This seamless connectivity provides the ability for guests in one property to make reservations in other hotels in the chain, i.e. allow cross selling between members of the affiliation. Nowadays, intranets are increasingly used for this purpose.

- *Single-site reservations systems*; these systems handle reservations that can come from different sources, e.g. telephone, letter, fax etc, solely for a single hotel property. Thus, the property based reservation system is important to integrate reservations coming from different sources. However, this level of integration refers to the internal integration of the reservation system with other hotel property ICT applications. This is explained in more depth as follows.

Reservations are perhaps the starting point for the majority of hotel computer systems because it is here that some of the basic information required by an integrated system is identified. The establishment of a reservation file is significant for further hotel operations because: 1) it saves time in registration; 2) it serves as an electronic guest folio whereby all bills are transferred; 3) it helps in building up a guest database and history file. So, when a reservation is taken staff can obtain not only the name of the customer but also the price that they are going to pay. If the intention of an integrated computer system is to charge the customer the right amount for their stay then the reservation stage is the opportunity to obtain information that can be used subsequently to compile accounts. As a by-product the reservation will allow such items of information as room status and market and sales analysis to be commenced. If the reservation system is fully integrated with internal ICT systems then a number of effects are going to be felt due to input of bookings from various sources.

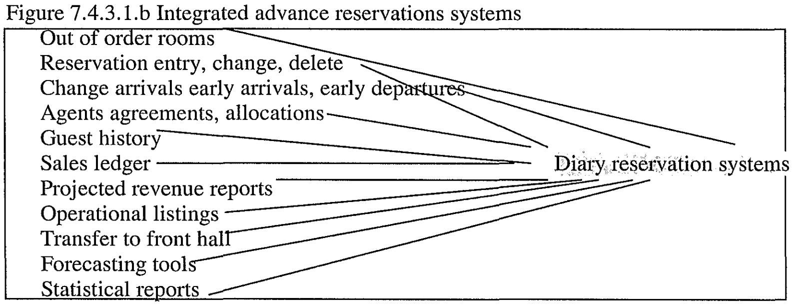
First, front desk staff will be looking for "walk-in" or "change" customers and as a consequence altering the availability of rooms on a minute-by-minute basis. Staff will also be informing the computer of guests who have decided to leave early and of guests who have decided to stay on longer than expected. An integrated system allows access to a common file containing the relevant information thereby enabling all staff to have access to the current availability situation. In other words, a single input of reservations data into the central files in an integrated system makes that data available to all the other users needing this information (Braham, 1988).

As it is a time-wasting process to have to enter guest details into the reservation system if the guests have stayed before, there should be the facility in an integrated reservations system to enter details direct from the guest history files, or even to make the reservation from this sector of the files. Using guest history will make sure that the guest preferences are spotted and acted upon. Similarly, the sales ledger files will be checked when making reservations for account verification and control and this will warn the reservation clerk whether a particular guest or company has had its credit withdrawn.

An integrated reservations system can also facilitate financial modelling by for example projecting the average room rate for any date or period in the future so that accurate forecasting may be undertaken. The forecasting may reveal many statistics under a number of classifications such as the take-up figures for tour operators with allocations of rooms, which may affect the sales policies of the establishment.

Overall, an integrated reservations system has at its core the central reservations files that are constantly being updated by reservation clerks, receptionists, cashiers and sales ledger clerks to provide a comprehensive profile of the mainstream business of the hotel (Figure 7.4.3.1.b). This database is vital to the effective operation of the system and the business and is the key to operational success.

Figure 7.4.3.1.b Integrated advance reservations systems



Source: Braham, (1988)

7.4.3.2 Central reservation systems

Central reservation systems refer to the computerised reservation systems developed by hotel chains for centralising the reservation process of all their affiliated properties. The major benefit of such ICT application is operational efficiencies and staff reductions. For example, the creation of a new North American Call Centre for Choice Hotels International, that was a part of a consolidation programme of its five reservation locations into three, actually eliminated approximately 100 positions, with another 40 jobs being created in the network, which finally resulted in a net decrease of 60 jobs. It has also been expected that the company will realise operating savings in its reservations fund of approximately $1.5 million in 2001 and $2 million in 2002 (Hotel-online.com, 2001).

Call centres have been a core component of hotel CRS. Connolly et al (1998) summarised the following telephony products, services and components that are used to make reservation call centres more productive and efficient:

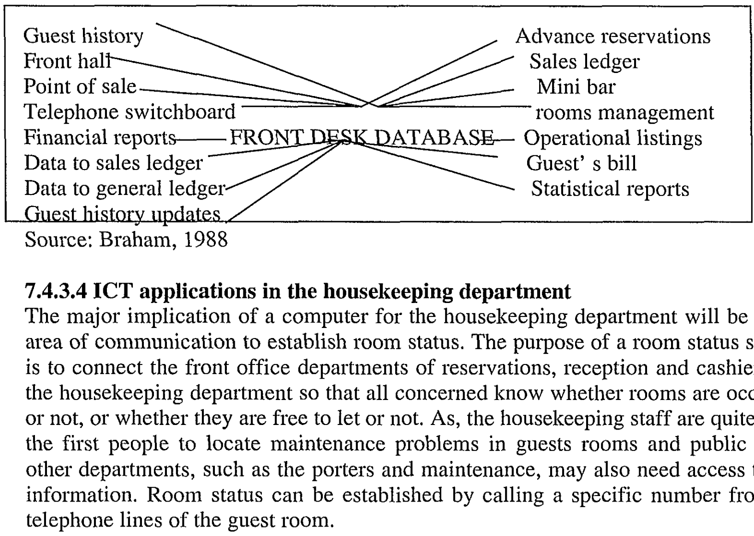
- toll-free number, which although until recently was country-specific, today is global, allowing single number to be advertised worldwide;
- automated call distributors (ACD's) which route calls to available agents, sometimes even at other hotels or call centres;
- report producing software regarding agent productivity, talk time, and total time spent waiting in queue (i.e. hold time);
- caller ID that benefits the reservation process by helping to recognise a caller and retrieve his/her travel profile and most recent reservation before the call is answered.

7.4.3.3 Front office applications

The front desk area of a hotel is probably the place where the guest is going to be most aware of the impact of computerisation (Braham, 1988). The work of the staff in the front office area includes the following tasks, which can easily be computerised: reservations, guest check-in, guest accounting, guest check-out, guest history, sales and marketing, room management, management reporting, sales ledger.

Thus, a front desk computer package will possess a very large number of functions (Figure 7.4.3.3.a), such as: detailed arrival lists, detailed departure lists, detailed room status reports, printed registration cards (automatically or on demand), express check-in/check out, automatic room status update, dynamic room display, complete room blocking capabilities, group registration/special billing, easy account prepayment and settlement, auto-post room/VAT at check-in upon demand for immediate guest receipt, multiple folio charging, charge dividing capabilities, charge posting controls and audit, correction and adjustment functions, end of shift cashier audit, a total of about 100 charge/settlement keys, detail folio display, fully automated night audit and close of day, guest ledger linked to city ledger, automatic transfer to guest ledger accounts to city ledger, fully automated close-month, close year , special forms, e.g. registration card forms and folio forms, front desk reports and guest messages (Braham, 1988). These functions may be part of a full front office computer package or available to front office staff through front-office integration with other ICT.

Figure 7.4.3.3.a An integrated front desk computer system



Source: Braham, 1988

7.4.3.4 ICT applications in the housekeeping department

The major implication of a computer for the housekeeping department will be in the area of communication to establish room status. The purpose of a room status system is to connect the front office departments of reservations, reception and cashier with the housekeeping department so that all concerned know whether rooms are occupied or not, or whether they are free to let or not. As, the housekeeping staff are quite often the first people to locate maintenance problems in guests rooms and public areas, other departments, such as the porters and maintenance, may also need access to this information. Room status can be established by calling a specific number from the telephone lines of the guest room.

A typical computerised housekeeping package will allow room status discrepancies to be quickly identified, as well as providing information on those rooms that are occupied, vacant or out of order. An additional feature will be the opportunity to keep track of extra-beds and cots, which might otherwise not be fully recorded.

The computerised system allows the housekeeping department to directly update room status into the central memory so that reception is made aware of room availability, which enables the reception staff to know exactly which rooms are prepared for the arriving guests. In the opposite direction will come details from reception outlining requests for bed-boards, for example, or late departures. In this vein, the ICT application acts as a two-way communication medium. The housekeeping department can print off lists of arrivals and departures in order to schedule staff along the most effective lines, whilst coping with sudden changes and requests. The system can also be used for keeping track of items loaned out by the housekeeping (e.g. cots, ironing boards etc), in order to ensure that they are returned even though a new shift may be on duty, as well as for linen reports and stock control.

Overall, the housekeeping package eliminates tedious maid scheduling and allows for more efficient scheduling of housekeeping services.

According to Cline (2001), hand-held guest detectors would be the electronic devices of future housekeeping, but also of other hotel staff, to determine if a guest is in a room. For example, a maid or a plumber using a hand-held guest detector would know if the guestroom was occupied and come back at another time to do the chores. The productivity implication of this technology is that hotels would enjoy a more efficient, cost efficient use of their staff's time, while hotel's relationships with customers can also improve as guests would be protected from being disturbed by hotel staff.

7.4.3.5 Check-in and check-out kiosks

Customer self, automated check-in and -out machines allow guests to bypass check-in and -out lines. Self check in/out kiosks are typically located in the lobbies of fully automated hotels. These terminals can significantly very in design, i.e. some may resemble automatic bank teller machines, while others can have a unique design and may possess video and audio capability. Recent ICT advances and particularly wireless technology (e.g. PDA, WAP and Bluetooth technology) enables self check in at airports, car rental agency locations or anywhere through a mobile device.

These terminals are connected to the PMS, and are activated by the swipe of a credit card. Automated kiosks are able to handle bookings made in advance and/or chance arrivals, allocate rooms, confirm all booking details, automatically prepare billing information, cater for newspaper delivery, morning calls and other services, activate air-conditioning, phone and voice mail for the room, while the guest can also be issued with a key, provided that required systems integrations are available. Once the guest is initiated at the check-in all guest charges are posted to his folio either manually or electronically.

Kiosks also allow guests to process their own check-out and receive their final bill immediately, which is crucial for busy travellers. Typically, the guest accesses the proper folio and reviews its contents, as the system communicates directly with the computerised PMS computer, within seconds, gathers together all guest charges from any area of the hotel – e.g. front desk, room service, telephones, restaurant and shop – and compiles them into a final bill. Settlement can be automatically assigned to the credit card, which the guest used at check-in. The check out is completed when the guest's balance is posted to a credit card (through an electronic fund transfer system) and an itemised statement of account is dispensed.

Kiosks can significantly reduce work-load and queues at the front office desks while providing an extra service and convenience to guests. They can also act as information machines when handling information of exchange rates, restaurant times, menus, weather forecast etc. This technology has also provided a high-tech solution for several of the most frustrating and persistent problems of operating a 24-hour reception, such as (Braham, 1988, p. 129):

- *Staff fatigue.* This is brought on by the constant disruption of a sleep or work pattern. Registering late arrivals is a primary cause. The attitude of even the most courteous member of staff might deteriorate with loss of sleep and an automated guest registration system can completely eliminate the problem by removing the need for staff to be on call at all hours. Automated kiosks also minimise the inefficiency and high costs that might result from excessive staff turnover.

- *High operating costs.* A significant percentage of hotel managers employ night staff but an automated guest registration system removes this need.
- *Lost revenue.* Automated kiosks ensure that hotels do not turn down bookings. when rooms are actually available in the hotel, which usually occurs when fed-up night staff decide to get some much needed sleep, regardless of potential demand.
- *Crime.* Crime can be a problem for hotels where a large amount of cash is in the reception tills late at night. An automated kiosk activated by credit card acts as an antirobbery device by eliminating the need to hold cash. It also reduces the need for expensive anti-robbery equipment and systems, decreases the threat of violence and may lower insurance premiums.

7.4.3.6 ICT applications in Marketing and Sales

ICT advances already have been a powerful means of transforming the sales and marketing function in hospitality and they are now setting the pace in the customer-focused hospitality enterprise of the future. This is evident in the following analysis.

Guest history

The use of technology in sales and marketing is not new; it started with guest history (1991), then database marketing arrived (1994) which was then led by data warehousing (1997) and the buzzword for today is Customer Relationship Management (CRM) (1999), (O' Connor, 2001). This evolution mainly shows the change of direction in ICT applications from tactical operations to more strategic and organisational wide practices. This is illustrated below.

The ICT application referred to as guest history revolves around the creation of a comprehensive database of guest details that can be easily accessed, distributed and retrieved. Previously, such information might have been kept in traditional handwritten files, but this meant that reference was often difficult and inconvenient. A computer system can simplify the whole process of keeping track of individual guests and also make that information readily available.

Information held in a guest history is usually divided into two levels; information in the first level that is open to virtually all staff, whilst the second level holds confidential information, possibly of a financial or personal nature, to which access is restricted. Examples of information gathered are: preferred room type and/or room number, address, phone, credit card number, travel agent, services requested during the last stay (e.g. extra pillows, newspaper delivery), the most recent visit, room rate, average expenditures per stay, type of payment, outstanding balance and date of birth.

With an integrated guest history programme future reservations are faster, smoother and automated, because instant access to the history saves input time. It also ensures that repeat customers' special requests can be anticipated. The guest history data becomes a ready source of information and automation for advertising and promotional campaigns. For example, when linked to a printer and accessible to marketing staff, the printer can be used to produce labels for a mail shot to all previous guests or specific market segments.

Before the use of computers, the analysis of customers even into nationalities was a very laborious task. On the other hand, most hotel databases have a number of basic statistics upon which the complete program rests, such as: a) market segment, i.e. the type of business for example a particular customer grouping such as chance, company meeting or tour; b) source, i.e. the person that actually makes the booking, e.g. travel agent, secretary; and c) channel, the method of the communication used to send the reservation to the hotel. The computerised rapid analysis allow managers to identify trends as they occur, rather than some time after it is too late to take action, and this allows much closer control of the business than would previously have been the case.

A marketing database can also allow staff to project statistics so that a forecast may be built up of what would happen if certain policies were pursued. The sales manager can so have better information on which to decide whether a certain marketing plan should be initiated. A computer with this marketing facility can automatically make the necessary calculations to allow accurate forecasts of the effects of a marketing policy on, for example, ARR, while the staff are also released from tedious calculations and can concern themselves more with the actual business mix.

The marketing database should allow the maintenance of an accurate profile of customers from which the best potential business prospects can be identified, thereby allowing marketing to be targeted accurately. Thus, the great advantage of a marketing database is that it allows the analysis of the customer base of the business easily, quickly and accurately. For example, a print out called a Marketing Plan Summary can be produced for the market segments (by room nights, occupancy, ARR and room revenue) and period for which detail is required and at a glance this will show such items as the forecasted ARR figures compared to actual ARR. Manually this information would have required many hours of calculations but with computers the marketing manager has access to the information almost instantaneously.

ICT applications in sales and marketing can also handle a hotel's group sales and function space. Braham (1988, p. 143) summarised the functionality of such a system:

- Automate the sales and banqueting office, negating the need for manual systems;
- Provide a support system for the sales staff by presenting a complete picture of room and function space availability;
- Improve customer service by giving quicker responses;
- Speed up sales decisions by having information to hand;
- Raise overall hotel productivity by providing a more efficient service;
- Provide an automatic list of imminent events giving the banqueting staff the opportunity to be prepared in advance;
- Improve inter-departmental communication by providing daily, weekly and monthly reports on all booked events;
- Eliminate time consuming work, e.g. manual preparation of statistics and reports;
- Create banqueting event orders within the system thus increasing efficiency.

The advantages of a guest history programme are particularly relevant where regular customers are concerned. A guest history system also provides the ability to recognise and reward "repeat" guests and this is important for the hotel's hospitality image. To book a return guest into a room or to anticipate requests and specific needs by giving a much more improved personal service (for example by automatically supplying their regular morning newspaper) guests can feel personally remembered and welcome.

Normally all that has to be done at the time of the reservation is to ask whether the guest has stayed before and then the relevant computerised files can be consulted and details confirmed with the customer. Such personalisation is not only impressive to the guest but also saves them the time and trouble of having to specify their likes and dislikes and should go a long way towards encouraging repeat business – one of the major aims of most hoteliers. Practices regarding the identification, building and maintenance of long-term relationship with loyal guests have been categorised in the broad area of database or relationship marketing and are reflected in the frequent guest programmes offered by all major hotel chains.

Overall, information regarding the guests' consumption patterns and preferences during their stay are recorded for three purposes (Sheldon, 1997): 1) to enhance future marketing activities, e.g. direct (e) mail; 2) to facilitate future reservations by not requiring the data entry of information, e.g. address, credit card details; and 3) to customise and personalise guest's future visits and experiences, e.g. room décor.

Nowadays, technology applications facilitating the tracking, rewarding and management of customers' relationships are considered as to be the killer "apples" for future cash flows (IHRA, 2000 and 1999). However, hotel operators are changing their approach to implementing them from a tactical to a more strategic and business integrated approach. Increased competition, globalisation, the growing cost of customer acquisition, the higher customer turnover, the increased sophistication and needs of customers are some of the major issues that have fostered such a change in direction in the hotel industry. The new approach and ICT application being adopted in the hospitality industry is called Customer Relationship Marketing (CRM). CRM is not just a reward programme, a quick fix, a computer system, a mailing list generator, a single source solution, a corporate department. CRM impacts marketing, customer service, product development, distribution planning and partnering. CRM is a business strategy to select and manage the most valuable customer relationships.

Kalakota and Ronbison (1999) defined CRM as an integrated sales, marketing and service strategy that precludes lone showmanship and depends on coordinated actions, while CRM experts (www.CRMguru.com online forum) claimed that CRM is a customer-centric business philosophy and culture that supports effective marketing, sales and service processes. Hence, CRM is driven by good technology infrastructure whereby integrated systems allow effective seamless access to and share of customer information that may exist in marketing, sales and service customer touch points. ICT infrastructure is critical so that the numerous systems at the touch points and communications (e.g. Internet, PMS, EPOS, CRS etc) do not become "islands" of useless information. Overall, CRM is a combination of business process and ICT that seeks to understand a company's customers from a multifaceted and 360^0 degree perspective, i.e. who they are, what they do etc.

The goals of CRM are to:

- Use existing relationships to grow revenue. Ogle (16/2/2000) claimed that the pursuit of customer loyalty would be the basis of hotels' sustainability in the future, since profits can be increased by 25-125% just by retaining 5% more customers. This is because it takes two to nine times less marketing expenditure per customer once "converted".
- Use integrated information for excellent service.

- Introduce more repeatable sales processes and procedures.
- Create new value and instil loyalty.
- Implement a more proactive solution strategy.

Overall, the new thing in the customer-centred nature of applications is that CRM organise processes around the customer, rather than marketing, sales or any other internal function. Measurement and feedback from the customer drive improvements in the CRM process, allowing it to change with the customer needs. In other words, in implementing CRM, hotels should base their actions not on the priorities of functional "field-doms", but on the overall corporate objective of providing customer satisfaction. To that end, as also previously argued, a hotel ICT application infrastructure that is centred around a corporate wide customer database rather than a PMS system might be more appropriate. Loftness (2001) summarised the following steps for implementing CRM in hospitality: a) development of measurement processes and culture around customer satisfaction; b) integration of customer information, whereby ICT integration is a must; c) customer profiling using data mining techniques; d) direct marketing practices; and e) personalised experiences.

However, for hotels, ICT integration is the most difficult area. Connolly et al (1998) identified the following difficulties for hotels for implementing integrated CRM:

- hotel information systems in use today are often referred to as "legacy" systems, meaning that they were written many years ago using tools and programming languages that are no longer state-of-the-art. Thus, these systems are often limited in their data querying, analysis and exporting abilities, which in turn prevents hotels from capturing and understanding guests' needs and behavioural patterns;
- the lack of consistency with respect to information systems within hotels compounds the collection, consolidation and analysis of guest information;
- the fragmentation of ownership and management of hotels makes it difficult to track a customer throughout an entire chain. Information collection and dissemination is not always feasible given inconsistent and incompatible systems;
- the data collection process itself is less than perfect. A guest often has multiple profiles (e.g. one for personal travel and one for business travel), while very rarely these profiles are linked in order to show the total contribution of the individuals;
- there is no agreed and common metric measuring the economic value of a guest. Guests that can promise to deliver value across time are important however at the same time guests may stay at different hotel chain properties as well as at different in importance nights (e.g. weekdays, vacations etc). So, for example, a business traveller who provides over 200 roomnights per year is generally considered as valuable repeat guest. However, if the bulk of these rooms are on a Tuesday night in a location that is typically sold out during this week, the value of this guest is less than another guest who stays fewer nights but mostly on weekends in the same hotel when rooms are usually unsold. Fully integrated YM systems with marketing, sales and distribution systems should be able to track such differences.

The future of CRM is argued to lie on Internet technology (i.e. e-CRM). While systems vary, most Web-based CRM systems work as data warehouses, pulling data from central reservation systems (CRSs) and PMSs. The data then go into a repository, in care of the vendor, where it can be sorted and analysed. Employees of any property then can access the database via the Web, provided they have a password. This process eliminates a hotel having to input data manually into a central system, but apart from avoiding the manual work, hotels can also accrue the following benefits when implementing CRM on the Internet (Oliva, 2001b; anonymous, 2001c):

- easily accessible data from anywhere and at any time;
- cut of cost, time and cost of database marketing;
- automation of the whole marketing and sale process;
- user friendly interface that requires limited user training;
- share and dissemination of data amongst multiple users within the same property and/or from multiple hotel properties;
- consolidated data gathered from different systems that in turn can be segmented into specific categories, by using data mining systems;
- automated e-mail campaigns;
- better integration of online and off line customer channels
- enhanced customer service and experience.

Distribution systems

Distribution is the system that makes products available to the market, in other words, *" it aims at providing the necessary information to the consumer in order to make a sale and allow for the sale to be confirmed",* (Mill & Morrison, 1992, p.400). Moreover, the WTO (1975, p.3) suggested that *" the primary distribution functions are thus, information, combination and travel arrangements services".*

Distribution channels have been extensively analysed in the literature for manufacturing industries. However, an early attempt to relate a definition to the tourism industry was made by McIntosh (1979, p. 23) and is cited in several books:

"...a tourism channel is an operating structure, system or linkages of various combinations of travel organisations through which a producer of travel products describes and confirms travel arrangements to the buyer"

Other authors have also defined distribution channels in the tourism industry as:

" a set of independent organisations involved in the process of making a product or service available for use or consumption " Lewis, (1995, p.647)

" the configuration of organisations and individuals between the hospitality marketer and his potential customer which is used to make the product more accessible and convenient " Buttle, (1986, p.277)

Moreover, the WTO (1975, p.13) suggested that:

"a distribution channel can be described as a given combination of intermediaries who co-operate in the sale of a product. It follows that a distribution system can be and in most instances is composed of more than one distribution channel, each of which operates parallel to and in competition with other channels".

However, these definitions underline the notion of distribution channels as "extra corporate entities", whereas a more deliberately definition should also allow to utilise the term when intermediaries are not used, as it is often the case in tourism, (Middleton, 1988). He highlighted this criticism in the following definition:

" A distribution channel is any organised and serviced system, created or utilised to provide convenient points of sale and/or access to consumers, away from the location of production and consumption, and paid for out of marketing budgets ",

Middleton, (1988, p.202)

Moreover, Middleton (1988) proposed that distribution channels should be approached as pipelines. Pipelines carry out various functions and thus, distribution channels are established wherever these functions are carried out. Therefore a better understanding of distribution channels is achieved by examining their functions. According to Middleton (1988, p.205), Holloway (1989, p.54) and WTO (1975, p.3) tourism and hospitality distribution channel serve the following functions:

- Provision of points of sale and convenient customer access, either for immediate purchase or for booking in advance;
- Distribution of product information, e.g. brochures and leaflets;
- Provision of display and merchandising opportunities;
- Advice and purchase assistance;
- Arrangement of product transfer, e.g. ticketing and travel documentation;
- Collection and distribution of sales revenue;
- Arranging details and ancillary services, e.g. insurance, passport assistance;
- Provision of marketing intelligence for principals;
- Promotion of particular products or packages, in co-operation with principals;
- Complaint handling for both customers and the industry;
- Undertake pre and post marketing research on consumers' needs and experiences;
- Assemble tourism products from different suppliers;
- Ameliorate inventory management by managing demand and supply.

Traditionally, the electronic distribution systems for hotels centred on a toll-free telephone number, one or more central reservation call centres and a Computer Reservation System, that mainly represent the Property based reservation system and the Central Reservation System as explained previously. However, new technologies, new standards and ICT capabilities have given rise to new distribution channels. Pollock (1995) systematically analysed and compared the features of latest digital channels with those of the analogue channels (Table 7.4.3.6.a).

Table 7.4.3.6.a Features of electronic channels compared with conventional channels

Feature	Conventional analogue channels	Electronic digital channels
Elements	Print brochures, guides	Electronic product databases
Content	Text and still images	Text, still and moving images, sound, animations and data
Information retrieval	Turn pages, index	Enter search criteria, software executable
Role of user	Passive	Interactive
Communication flow	Uni-directional	Bi-directional
Currency	Fixed in time, limited shelf life	On-line sources can continually updated
Reach	Limited by reproduction and postage	Limited by consumers' use of digital reading devices (CD-ROM players, modems); otherwise global
Appeal	Must appeal to the common interests	User can customise information from large source
Amount of content	Limited by reproduction, postage costs	For practical purposes, limitless
Versatility	Low, most print products are single purpose	Very high, digital data can be distributed in a variety of formats and channels

Source: Pollock, (1995)

Airline GDS

The first revolution of electronic distribution channels for hotels came with the use of Global Distribution Channels (GDS), the latter being fostered by the increased breath power, reach and coverage of Computer Reservation Systems provided by airlines to include sales and information of other travel related services, e.g. hotels, car rental companies, exchange rates, etc (Inkpen, 1994; O' Connor, 1999; Emmer et al, 1993). As numerous travel agents have accessibility to GDS, hotel listing in them is crucially important specifically for targeting the business travel market (Table 7.4.3.6.b).

Table 7.4.3.6.b GDS penetration in the travel agent sector

Terminals	Galileo Int		SABRE		Amadeus/System One		Worldspan	
	No	*%*	*No*	*%*	*No*	*%*	*No*	*%*
North America	15,494	30	18,783	36	7,575	14	9,760	19
Europe	12,372	25	5,783	11	25,777	51	6,700	13
Rest of world	8,838	32	8,887	32	8,976	32	955	4

Source: O' Connor (1999)

With the proliferation of the electronic distribution channels, hotels nowadays have many more options for ensuring an electronic shelf space. However, hotel listing in the airline GDSs is still fundamental in hotel electronic distribution because: a) airline GDSs not only provide access to the travel agent market (some 500,000 agents according to Forrester Research); b) they are also increasingly being used as the backbone of many and powerful Internet travel booking services (e.g. expedia.com uses Worldspan, priceline.com uses Sabre, hoteldiscounts.com uses Sabre and Galileo, previwtravel.com uses Galileo etc) (Connolly et al, 1998); and c) because GDS themselves are also taking benefit of technological advances and enhancing their reach and rich, i.e. they are becoming ubiquitous, mobile and accessible in different platforms and so, increasing their captive market and audience as well as they are becoming a one stop shop by including more and more services/products into their platforms offering enhanced convenience and services to their users. On the other hand, airline GDS have also developed their own gateways to the Internet (e.g. Sabre owns travelocity.com, Amadeus has developed the amadeus.com travel portal) and so they are making themselves accessible to the leisure travel market as well.

However, connecting hotel reservation systems to airline GDS has been costly and problematic but necessary if hotels want to take advantage of the global travel agent market and the online marketspace. In turn of their services (listings and reservations processing), GDSs charge transaction fees for every booking or sale processed, while hotels are responsible for the information displayed about their facilities, rates and availability. To maintain this information, the large hotel chains invested heavily in the development of interfaces between their GDSs and the airline GDSs.

However, these interfaces are not only costly to develop but also costly to maintain. They require constant updating due to the dynamism of the airline GDS market and recent changes in the hotel industry. Moreover, the implementation of YM in many of the large chains also results in thousands of price updates each day to each airline GDS (this also highlights the need for a seamless integration between YM and hotel GDS). O'Connor (1994 and 1999) also highlighted that efforts for displaying detailed and easy-to-use hotel information in airline GDS and for synchronising databases in real-time are adding to the administrative burdens of managing a hotel's distribution system. Particularly, the delays in transmission between airline GDS and a hotel CRS, the batching of transactions, and the processing of error messages that result from incompatibilities between different systems creates a cumbersome queuing process that must be closely monitored to avoid overbooking and to ensure that reservations are received at the hotel before the guests arrives. Both manual and semi-automated processes rely extensively on queues and so often, dedicated staff are required to manage these queues. As a result, the high costs and complexity of these interfaces put them out of reach of the smaller chains and independent hotels, and the gap between *"haves"* and *"have nots"* became evident.

Universal switches

To close the gap and gain access to airline GDS (and so the travel agency market), independent hotels became part of franchised chains or built independent networks. The closing of the gap between hotel CRS and airline GDS started about ten years ago with the development of universal switches and the rise of reservation service firms like Utell International and Pegasus systems (the ex THISCO systems company). These electronic switches (or else referred as clearinghouses) are communication devices that essentially translate, convert and exchange information between hotel systems (CRSs or PMSs and airline GDSs). With a switch in place, hotels need develop and maintain only one interface to the switch of choice. The switch provider then develops and maintains all linkages to external systems. Although there are still subscription fees, transaction costs and interfaces to be maintained and paid to the switch company, the overhead is significantly lower than maintaining four separate links to each of the four major airline GDSs. Additionally, the switch vendors provide more leverage for the hotel industry when negotiating for added functionality in each airline GDS. Because of the connectivity they provide, the switch companies have quickly become one of the most influential and strategic components in a hotel GDS network. Today, these switches help to level the playing field, providing all hotels (independent and chain-affiliated alike) with equal access to the airline GDS.

In fact, there are currently only two switch companies in the marketplace: Pegasus Systems' THISCO and WizCom. Nowadays, hotel connectivity to and listing in these switches has become more valuable since the latter have also increased their own services and electronic exposure (e.g. Pegasus operates the online travel site travelweb.com, while WizCom operates travelWiz.com). Both Internet booking services are connected to their respective switches to provide consumers with online hotel booking capabilities. This development also means that independent and small hotels can also get listed on airline GDS through these online service providers without any other technology investment. Nowadays, though listing on airline GDS is also offered by several reservation Internet based companies (e.g. all-hotels.com, wordres.com) by paying them a small fixed fee for listing and/or transaction.

Overtime, linkages between hotel's property-based systems, its chain's CRS and airline GDS have improved. Vallauri (1995), Coyne and Burns (1996) and O' Connor (1999) discussed a number of different levels of GDS interfacing (e.g. Type B, type A and Type S seamless connectivity). However, not all hotels have the technology to support such seamless connectivity and so, the transfer of data may be done manually or by multiple sets of books one for each system interface (i.e. by allocating specific room and rate inventory to each channel). Because multiple sets of books are not always properly synchronised, credibility issues still remain and hoteliers feel the loss of control over inventory. On the contrary, with automated linkages between core systems, much of the manual, human oversight is eliminated and access to "last room availability" is provided to the major points in the distribution network.

Early enough Emmer et al (1993) had predicted that one day the focus would shift to building seamless access directly between airline GDSs and hotel PMSs. And indeed, today the challenge is to move towards seamless connectivity, where a travel agent or other member of the extended sales force can "look" directly into and book within a hotel's CRS (Vallauri, 1995). Using the approach of seamless connectivity, a travel agent or other member of the extended sales force is granted access to the same set of information and last room availability that had typically been restricted to internal sales associates. In effect, this eliminates the need for multiple sets of inventory books, creating a single-image inventory. Since each point in the distribution channel has access to and is quoting from the same set of information, credibility in the process is greatly improved. Instant confirmation (generated by the hotel company's CRS) can be provided, and each hotel company has control over how its properties are displayed and the types of information regarding facilities and services that are provided. Thus, complete integration of a hotel's PMS, CRS and the airline GDS is a fundamental tenet to provide travel agents and other external sales agents (including customers who book directly from the Internet) with the ability to book last room availability right down to the individual property level.

Lack of seamless interfaces and a single-image inventory can prove counterproductive or as Emmer et al (1993) claimed suicidal and this is because:

- It is an impediment to delivering consistent, high quality customer service. Without this capability, travellers or travel agents are not necessarily guaranteed access to accurate and timely information. Rates and availability may be obsolete. As a result of a misinformed customer base, a hotel or intermediary can unwittingly turn down business and frustrate customers.
- Restricted access to inventory and rates creates inefficiencies in the distribution process, because it causes the development of a hierarchy with an associated degree of bureaucratic processes.
- The inconsistencies in rooms' rate and availability amongst distribution channels can lead to distrust and tainted reputation.
- Incomplete data necessitates guests, travel agents or any other user to take additional efforts to fill these informational voids. For example, users end up accessing one or more of the hotels' distribution channels, but which in turn leads to unnecessarily tax of distribution channels, driving up the costs of maintaining distribution channels and service customers.

However, several obstacles may inhibit hotels achieving seamless connectivity such as (Connolly et al, 1998): age, inflexibility and lack of hotel functionality contained in airline GDSs; the legacy systems used by hotels; the fragmentation of ownership within the hotel industry; inconsistent applications and technology hardware platforms in use throughout hotels; and the lack of standards for interfacing and data transfer.

Moreover, hotel distribution through electronic intermediaries is not only difficult to build and maintain but also costly to use. Costs assigned to each channel vary, but they are typically based on pre-negotiated volumes. Some channels require fixed fees and transaction fees, the latter generally based on net bookings (i.e., reservations booked less cancellations), but in some rare cases, a transaction may be defined as any database query or inquiry (i.e. availability check or address look-up). Connolly et al (1998) reported the following average costs (in US$) for a single reservation:

- travel agent or intermediary commission: 10% of the total room revenue;

- airline GDS fee: $3 to $4
- Universal Switch: $.25 to $.75
- Hotel CRS: $8 to $12

Although these costs may individually be quite low, they can quickly accumulate and represent reportedly as much as 40% of a hotel's daily room rate. For example, consider a hotel room that sells for $150. If the reservation is made through a travel agent accessing an airline GDS which transfers the reservation to the hotel CRS via a universal switch, the cost of the transaction will be $31.75 or 21% of the room rate, which represents a substantial erosion in the profit margin. Thus, it has become essential to direct reservation traffic to those channels that are able to meet hotel distribution needs but at lower operating costs or even to eliminate intermediaries. The cut down of the middlemen or the disintermediation of traditional players of the travel distribution chain was argued to be fostered by the introduction of the Internet, as the latter empowered hotels to get a direct access to their customers. However, the dynamics fostered by the Internet evolution have been much more complicated, as the online distribution: a) represents opportunities and threats for all players in the travel distribution channels (both suppliers and intermediaries); b) it fostered re-intermediation in the travel distribution chain, in other words it enabled new players to penetrate the travel industry (that might also come from other industries, e.g. Microsoft) by giving rise to a new type of intermediaries (or else called infomediaries or cyberintermediaries) such as priceline.com, nameyourownprice.com, hoteldiscount.com; and c) it fosters dynamic and constant changes that continually change the power, relationships and configurations in the travel distribution chain, which keep the latter under endless re-engineering. Internet dynamics regarding online hotel distribution are analysed in more detailed as follows.

E-commerce: Internet – WWW

The Internet and its related technologies (Intranets and Extranets) consist the second revolution in hotel electronic distribution. The Internet is a global network of computers that share a common transmission language to enable the sharing and transmission of digital data and applications on a wide scale. According to Hoffman and Novan (1994), the Internet can be described as:

1) a network of networks based on TCP/IP (transmission control protocol/Internet protocol);
2) a community of people who use and develop those networks;
3) a collection of resources that can be reached from those networks.

In comparison to traditional media, the Internet combines and integrates the following functional properties: information representation; collaboration; communication; interactivity; and transactions. Moreover, "log files" and "cookies" incorporated into the Internet enable the collection of immense amounts of detailed information about Web users, which in turn can be used in intelligent and innovative ways to gain greater insight about customers. Sigala (2001a) identified the three Internet tools and capabilities that are becoming available to any player. These are: 1) interactivity, i.e. the ability synchronously or asynchronously to communicate/collaborate with others online, while simultaneously gathering an enormous amount of multimedia information; 2) connectivity, i.e. everyone with an internet access can have a web store front, which in turn gives rise to network externalities, economies of scale effects, while it overcomes time and space barriers in conducting business; and 3) convergence between media, content, hardware, software and telecommunications leading to the digital economy. Because of these features the Internet is creating a new competitive scene, the virtual marketspace, whereby companies need to address and compete by managing three dimensions namely reach (exposure), richness (information regarding their products and their customers) and digital representation (the fact that customers cannot feel, see and experience the product online).

In fact, the Internet is creating a "Webolution" in today's society changing the way people live, work, interact and shop, the way goods/services are produced, sold and distributed as it impacts all aspects of the value system and chain. Recent studies (forrester.com and PhoCusWright.com) predict increasing consumer adoption of Internet and e-commerce, while as computers are gaining ubiquity so does the importance of Internet. Gartner.com predicted that accessibility to the Internet through devices apart from the PC (e.g. Personal Digital Assistants, mobile phones, digital TV or even recently microwave ovens) is predicted substantially to exceed PC Internet access giving a further boost on e-commerce activities.

However, although it is a common practice today to add an "e" prefix or a "dot.com" suffix to almost any word, the concept of e-commerce (electronic commerce) came into being in the early 1970s with the advent of the first computer-to-computer transactions and electronic data interchange (EDI). The new thing nowadays is though the level of attention being devoted to it, the pace of change and the resultant business transformations occurring as the result of e-commerce investments. The impact of these changes becomes more crucial as advances in Internet technology have introduced a wide range of new marketing tools, which are both accessible and affordable for smaller organisations. Indeed, Connolly and Sigala (2001) claimed that the Internet has an equalizer effect as it creates a level playing field where size is no longer apparent, while Kalffe (1996, p.4) predicted that *"Beryl's GuestHouse in Bognor could soon be rubbing shoulders with the Marriotts and Hilton's"*.

As the Internet is an open infrastructure for all players, small and big, it is an invaluable tool for SMTEs that usually suffer from limited capital, economies of scale, expertise and international exposure (Buhalis and Main, 1998). Indeed, the equaliser effect fostered by Internet technology is widely mentioned in the literature. For example, Quelch and Klein (1996) highlighted that the Internet will lead to more rapid internationalisation of small and medium sized enterprises, especially hotels in the tourism industry, reducing competitive advantages of scale economies, cutting global advertising cost. Sigala (2000a) illustrated how Internet is empowering small and medium Greek hotels that are traditionally very dependent on tour operators.

Moreover, as the Internet provides a platform for collaboration and co-operation, Poon (1988) argued that there will be no place for the stand-alone participants, but the world would become the oyster for the small, innovative, flexible and networked enterprises. The idea is to establish collaboration ventures, which would enable small firms to pool resources and share development and operation costs (Buhalis and Cooper, 1998; Buhalis, 1999). Networks of shared costs/resources/information can assist small hotels to alleviate some of the constraints of being small sized and enable them to obtain more benefits from scale economies (Buhalis, 2000). Buhalis (1999) systematically outlined the benefits and the costs of Internet for SMTEs (Figure 7.4.3.6.a).

Figure 7.4.3.6.a Cost/benefit analysis for developing web presence for SMTEs

Costs
- Costs of purchasing hardware, software and communication package
- Training cost of users
- Design and construction of internet presence
- Cost of hosting the site on a reliable server
- On-going maintenance and regular updating
- Marketing the internet service and registration of domain
- Development of procedures for dealing with internet presence
- Commissions fees for presentation in search engines and other sites
- Interconnectivity with travel intermediaries such as TravelWeb, ITN, Expedia

Benefits
- Direct bookings, often intermediaries, and commission free
- Global distribution of multimedia information and promotional material
- Low cost of providing and distributing timely updates of information
- Global presence on the Internet, 24 hours a day, 365 days a year
- Durability of promotion (in comparison to limited life of printed advertising in press)
- Reduction of promotional cost and reduction of brochure waste
- Great degree of attention by visitors to web site
- Reduction of time required for transactions and ability to offer last minute promotions
- Low marginal cost of providing information to additional users
- Support of marketing intelligence and product design functions
- Great interactivity with prospective customers
- Niche marketing to prospective consumers who request to receive information
- Interactivity with local partners and provision of added value products at destinations
- Ability to generate a community feel for current users and prospective customers

Source: Buhalis, (1999)

The Internet can also reduce the capital and operations costs required for promotion, advertising, distribution and reservations. For example, the cost per individual booking can be reduced from $10-15 for voice-based reservations, to $3.50-7.50 for reservations through GDSs or to $0.25 through the WWW (Beaver, 1995). Moreover, a hotel property website is the only distribution channel whereby costs per reservation decrease when the number of reservations increases (because since no commissions are paid the cost of investment for creating a website solution is divided by a greater number of reservations).Thus, the more reservations hotels can transfer to the Internet, the more savings they could have. Savings are also achieved in printing, storing, administering, disseminating promotional material. For example, PhocusWright.com reported that Marriott has been able to save US$2 per Internet booking using its own booking engine instead of an outside source. Hilton saves US$25 on each Web site booking compared with a traditional travel agency booking, while Hyatt's cost for an online booking is US$3, compared with US$9 to book via the call centre.

Overall, online reservations can lead to several tangible and intangible benefits that can be summarised as follows:
1. provide quicker and more accurate response to the customer;
2. enable reliable forecasting of revenues and occupancies;
3. reduce reservations clerical procedures thereby enabling more time to concentrate on marketing and promotion;
4. eliminate paperwork and physical filing;
5. facilitate changes that must be made to the reservation record;
6. provide immediate visibility into who the guest is and what the guest needs are and at a time prior to registration;

7. enhance the speed of registration by permitting a transference of data from the registration record to a registration card or its equivalent;
8. provide for a pre-occupancy guest record to which payment advance deposits and cash pay-outs can be accurately posted and carried forward;
9. establish an initial record that accompanies the guest through the guest cycle thereby giving management tighter control over guests' transactions.

However, e-commerce does not only involve online reservations. E-commerce was defined as the entire process of buying and selling goods/services/information electronically with computerised business transactions using the Internet, networks, and other digital technologies (Laudon et al, 1999), meaning that e-commerce also encompasses activities supporting those market transactions, such as advertising, market research, customer support, delivery, and payment. In this vein, Werthner and Klein (1999) summarised the benefits of e-commerce as in Table 7.4.3.6.c.

Table 7.4.3.6.c The value of e-commerce

Applications	Examples
Revenue from distribution and services	Direct distribution of books, flight tickets, computer hardware and software, banner advertising, cooperation with other electronic commerce companies
Revenue from advertising	Banner advertising, cooperation with other electronic commerce companies
Detailed market research data	Own market research, selling customer data as long as customers agree
Integral part of marketing with positive results in traditional media	Cross marketing via different media, advertising in print media for Web activities and events such as ticket auctions
Cost reduction through: • Efficient presentation • Automation • Passing onto customer • Efficient transactions • Disintermediation • Better planning accuracy • Improved capacity usage	 • Advertising • Service sites • Kiosks • EDI, electronic ticketing • Direct distribution • Well suited basic products, which can be easily aggregated • Production on demand

Source: Werthner and Klein, (1999)

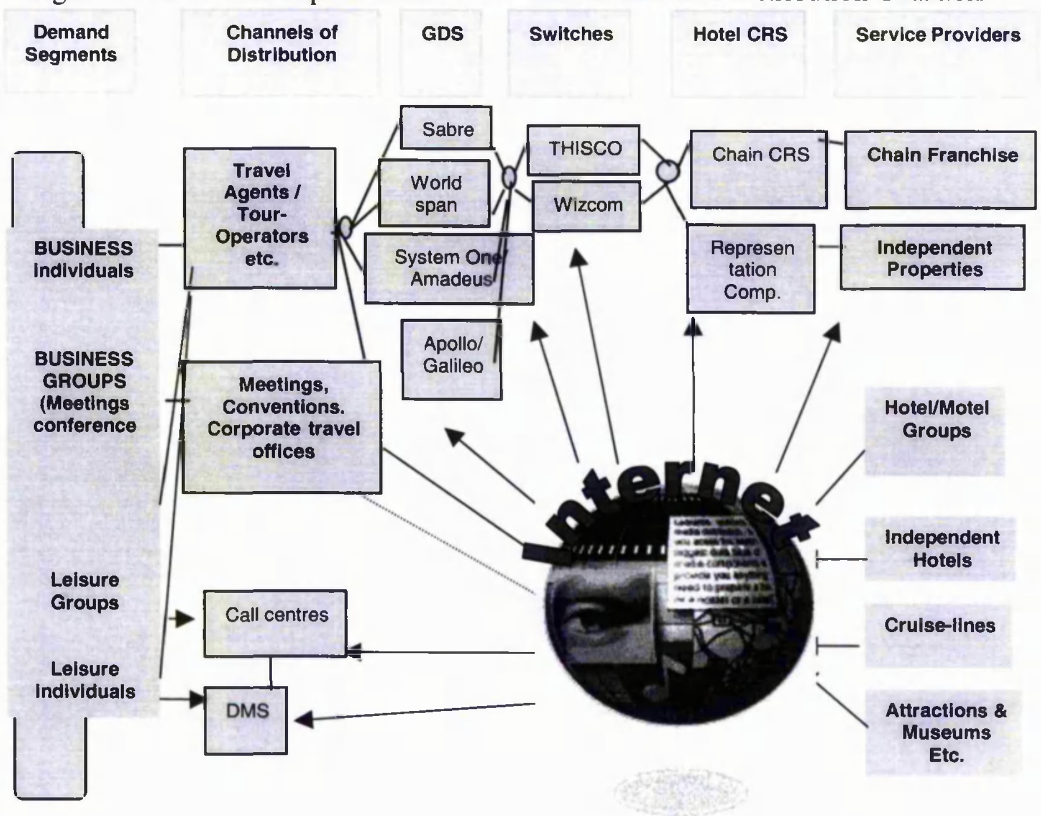
However, nowadays, the cost efficiency of Internet reservations is being questioned. Internet is undoubtedly a cheap channel to drive reservations but costs that are being saved are spent on more marketing and advertising efforts elsewhere or on maintaining and upgrading computer networks. Don Brockway (in Gillette, 2000), vice president of worldwide reservations for Choice Hotels International argued that:

"I may reduce labour costs on the voice side but on the electronic side, there is a lot of cost involved. A lot of money that went to reservation operators now goes on training people on computer skills and maintaining all (Internet) channels connections, software and hardware to make the total system seamless to the consumer. We had to hire more support people on the electronic side, plus there are fees we pay for our presence on various Internet sites".

On the other hand, not only hotels but all players of the travel distribution chain are trying to establish an Internet gateway in order to guarantee online exposure and safeguard their market share (Figure 7.4.3.6.b). As a result, the Internet did not only enable hotels to create new possible ways of reaching the customers but it also proliferated both the number and the business model/type of the distribution channels (web based travel infomediaries are mushrooming) as well as it enabled interconnections and interfaces between systems that were not possible before (e.g.

between systems within the same hotel property or with systems with third parties). Figure 7.4.3.6.b highlights the proliferation of hotel distribution channels due to the Internet advent, as all traditional players (e.g. travel agents, hotels, airline GDS, switches) have an Internet storefront. In addition, the new types of travel intermediaries such as priceline.com, ITN.com, e-bay.com, should of course be added.

Figure 7.4.3.6.b The Impact of Internet evolution on Hotel Distribution Channels

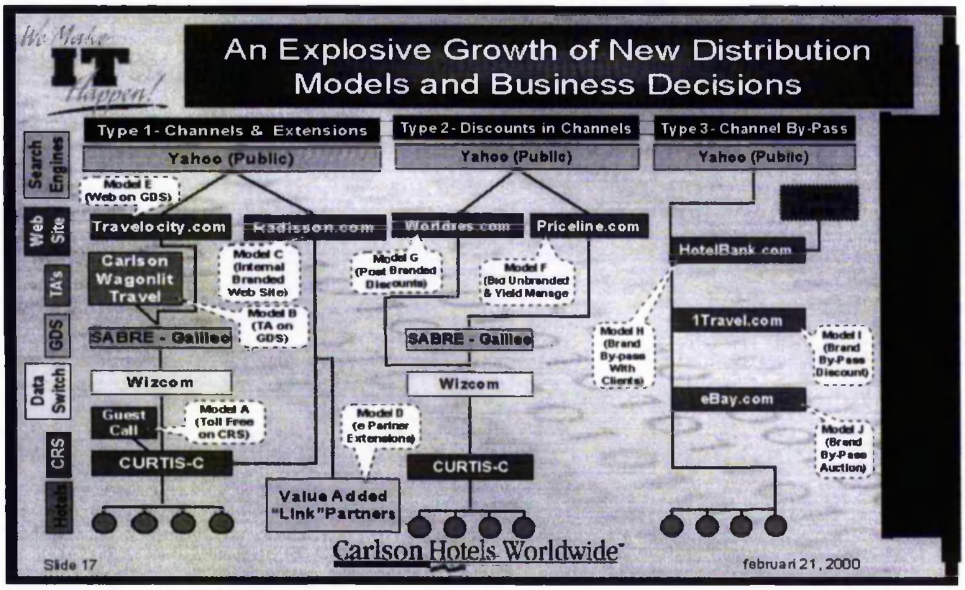


The proliferation of hotel distribution channels is basically having three main effects in the hotel industry: a) it provides a great number of alternative channels for getting greater online exposure and so getting more reservations; b) it provides a great number of different types of distribution channels that can be used dependent on circumstances; but c) on the other hand, it enhances online competition for attracting online traffic while giving more power to customers and at the same time so that hotels are finding it more difficult to attract eyeballs and keep guests loyal to their own websites. In fact, when guests book online through third party websites then the disintermediation effect of the Internet is not being materialised as hotels still need to pay listing and commission fees to online middlemen that forward them reservations.

O' Connor (1999) identified the following categories of online distribution channels available to hotels: GDS websites (e.g. travelocity.com); CRS based websites (e.g. hyatt.com); Switch company websites (e.g. travelweb.com); Representation Companies Websites (e.g. utell.com); Destination Management Systems websites (e.g. www.tiscover.com); Web Based infomediaries (www.priceline.com); Property based website (e.g. www.hotelname.com); auction/bidding websites (e.g. e-bay.com).

Carlson hospitality has actually classified its electronic distribution channels into three different categories (Figure 7.4.3.6.c) and actually the way that it manages electronic distribution clearly reflects: a) how hotels can benefit from the different business models of distribution channels for managing room capacity and rates depending on demand circumstances; and b) the interrelationship that exists between marketing ICT applications, i.e. in this case YM system and distribution channels. Analytically, the first type of distribution channels involves the traditional channels and their extensions that are allocated to sell the majority of room inventory, a smaller proportion of room inventory is sold though discount channels (www.priceline.com) and channels in category three that are actually reversing the price mechanism by allowing auctions are only used for selling distressed room inventory (capacity that has not be sold until the last minute). There are two main reasons for such categorisation and practice: a) to avoid alienating existing relationships with profitable and traditional channels; and b) to avoid customer frustration and commodisation of the hotel product mainly due to web companies using auctions.

Figure 7.4.3.6.c Carlson Hospitality distribution channels



Source: Wagner (2001)

On the other hand, although online distribution channels may substantially increase online exposure and sales for hotels, the latter are finding it more and more difficult to attract traffic and get online reservation through their own websites. Indeed, as figures gathered from www.PhoCusWright.com revealed, although the gross value of Internet hotel reservations was US$2.6 billion in 2000, i.e. up 136% from 1999, of that, only 55% of bookings came from hotel-branded Websites, while the 45% came from online travel agencies and other infomediaries such as travelocity.com and expedia.com. The same trend is predicted to continue, i.e. Internet bookings are projected to reach US$4.6 billion in 2001, with 53% booked through hotel Web sites.

Moreover, the Internet revolution, the proliferation of business models of online travel companies (e.g. consumer auction websites such as lastminute.com, nameyourownprice.com) and the increased use of intelligent agents by both consumers (i.e. shopping agents) and sellers (i.e. sales agents) are also creating an increased transparency of prices and information that in turn tremendously increases consumer power. Consumers also want better service, more personalised, on time and accurate information, while they are also becoming more mobile, critical, less loyal and more price sensitive and tend to buy on a last minute basis (Sigala, 2001b).

In order to face these challenges, increase consumers' "eyeballs" and "stickiness" to their websites, hotels need to extend e-commerce's role from a simple creation of a website to a more enhanced online storefront that would gather customer information and use it for providing customer interactivity and personalisation. As several authors claimed (Sigala, 2001a; Sigala, 2001b; Pollock, 2001; Evans and Wurster, 1997; Azzone et al, 2000; Weeks and Crouch, 1999; Van Hoof et al, 1999; Procaccino and Miller, 1999; Jarvela et al, 1999; Hoffman and Novan, 1994), businesses should move from the "Brochure ware" era of the Internet exploitation, provide more personalised products and services while developing and implementing a website strategy. For example, Evans and Wurster (1999) argued that the struggle of competitive advantage on the Internet would be along three dimensions namely reach, richness and affiliation, i.e. efforts to create and maintain long-term customer relations. O'Connor (1999) claimed that electronic distribution strategies should aim to achieve reach, content, interactivity and feedback in order to provide value-added services and lock up customers. Zott et al (2000) also claimed that personalisation of product or information and the development of virtual communities create website "stickness", a crucial feature facilitating repeat transactions. Indeed by benchmarking e-marketing strategies, Sigala's (2001b) findings revealed that hotels that have transformed their e-marketing mix by fully exploiting Internet capabilities (i.e. interactivity, connectivity and convergence) outperformed hotels that used the Internet solely as a communication and information dissemination medium.

Thus, the aim of e-commerce extends beyond product/brand awareness and exposure to achieve conversion of "lookers" to "bookers", to win customer loyalty and so, capture and maintain sales. To that end, hotels must build capable, reliable, flexible and interactive technological infrastructures that can support the growing volume of requests and transactions in real-time, secure and customer-personalised manner.

For achieving competitive e-commerce practices, IT Think Tank participants (IHRA, 2000) also highlighted the need for:

- a single image to room and rate inventories seamlessly integrated to websites for allowing real time online reservations in order to decrease the possibilities in inconsistencies among different channels; that in turn will increase customer confidence for buying online and not shop around.
- a centralised hotel-wide data warehouse (whereby the Internet would be one of its customer touch point) that would allow personalisation, CRM and differentiation practices on the Internet in order to address the increased commoditisation (i.e. competing on price only) and lack of customer ownership on the Internet (Connolly and Sigala, 2001; Sigala, 2001a; Olsen and Connolly, 2000).

However, a study conducted by Arthur Andersen (Cline and Warner, 1999) revealed that only 39% of the industry's Websites can handle reservations on a real time basis, even fewer still (19%) collect customer information, only 22% are using "push" marketing programmes and only a minority (19%) have extranets to customers or suppliers. Similar findings were reported by Sigala (2000b), whereby very few hotels (40%) had been using the Internet for transforming more than three dimensions of the e-marketing mix. In fact, the majority of them were using the Internet for publishing information and price lists, while enhanced features such as online bookings, online dynamic pricing, CRM, personalised products/services etc were offered by a very small proportion of hotels' websites. Moon et al (2000) also reported that most legacy hotels' ICT systems have not been engineered to handle the volume, content and query capabilities required of an online presence in the distribution channel and so, the vast majority of Website screens do not mimic how consumers buy hospitality and travel products/services (Moon et al, 2000).

However, there are hotels (mainly big hotel chains) that can afford and do offer enhanced website features and practices. For example, Marriott.com is the first lodging website to provide a personal profile reservation service (www.hotel-online.com, 2000). The added personalised features can streamline online reservations by eliminating the need to re-enter personal information. Travellers can voluntarily register and update basic profile information such as method of payment, preferred hotel brand, preferred room type, Marriott Rewards membership number and e-mail address. Travellers also receive an immediate reservation confirmation via e-mail. Marriott offers a Personal Planning Service online whereby customers can use it in order to plan a customised vacation at selected Marriott Resorts.

Apart from developing enhanced website features, hotels are engaged in another three practices in order to drive business to their online distribution channels. First, hotels have begun to partner with large corporations to bring their website into the latter's Intranet travel page. For example, Marriott is trying to sell its website to the Intranet of its major corporate clients and to that end it developed a program called Corporate America that currently allows business travellers of 10 companies to link to Marriott's website through his or her company's Intranet.

Moreover, realising the power and the growth potential of GDS on the Internet, some hotels are jumping to form additional partnerships. Wydham, Marriott and Hyatt are amongst the first to become vendors through Orbitz, the online travel distributor owned by major airline companies (Delta, Continental, Northwest and United). On the other hand, Graham (2000) argued that in fighting back, some major brands find it more value added to align with competitors in the industry rather than align with the new intermediaries. In fact, at the same time hotels also try to get online customers out of GDS empowered websites (so that they can avoid paying commission costs and also "own" the customer, i.e. build customer databases and customer loyalty) by developing reservations portals based on their own technology. So, several hotels come together forming reservation portals to compete with the GDS based ones. Hilton International, Granada's Forte Group and Accor of France have formed an alliance to develop an online reservations portal for all of their brands (Alford, 2000), while another group consisting of Marriott, Hilton and Hyatt is also developing its own shared global reservation portal on the Internet (Connolly et al, 1998).

Overall issues and model of hotel electronic distribution

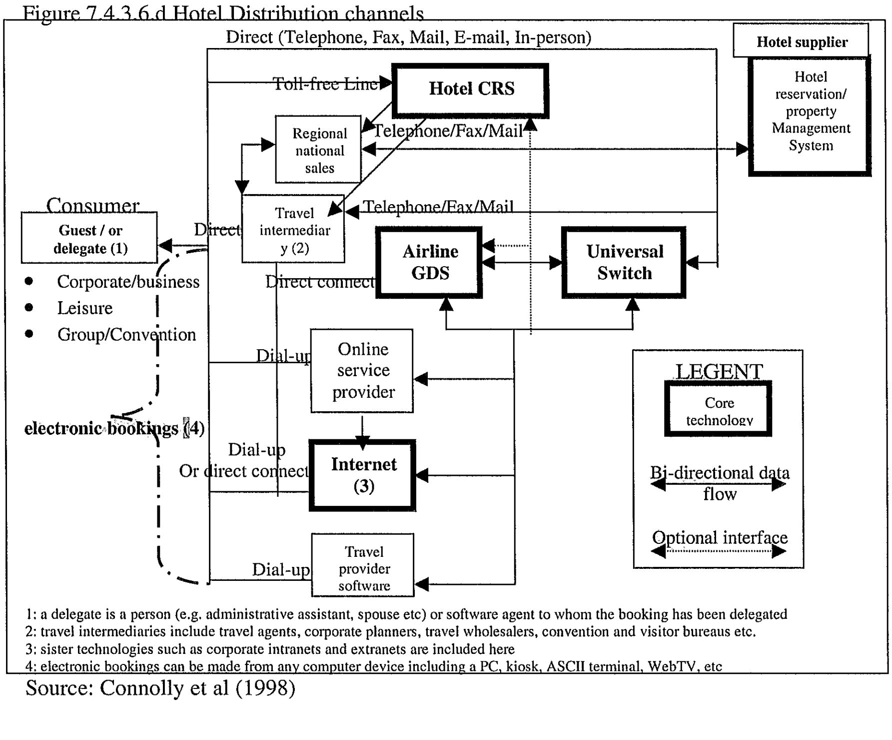
As the hotel industry embark on the e-business lifecycle, management should clearly look for investing in new technologies, systems and practices that address both the cost reduction and revenue enhancement benefits. To that end, Cline (2000) identified the following factors that should be considered: a) company's ability to identify and recruit the most valuable customers; b) the ability seamlessly to cross-sell the company's products and services, as well as those of alliance partners; c) the ability to retain valuable customers and reduce attrition (especially nowadays that brand loyalty is questionable and branding is erasing); and d) when and how to eliminate costly and unnecessary discounts through revenue optimisation.

Connolly et al (1998) also identified the following major trends and issues that need to be considered in electronic distribution in the hospitality sector:

- rising costs of distribution that will shrink contribution margins;
- a greater number of rooms being sold by intermediaries or intermediary services;
- more requests for significant room discounts by these third-party service providers who will become aggregators or travel wholesalers;
- the provision of a single image inventory (i.e. the same information, rates, and availability displayed to property staff, reservation agents, travel agents etc);
- real time access and last room availability to each distribution channel at any time and from anywhere while maintaining control over hotel inventory and costs.

Figure 7.4.3.6.d provides an overall framework of the configuration of the hotel electronic distribution chain. The different electronic distribution channels as well as the links amongst them facilitating communication and transactions between the guests (left end) and the hotel suppliers (right end) are illustrated.

Figure 7.4.3.6.d Hotel Distribution channels



1: a delegate is a person (e.g. administrative assistant, spouse etc) or software agent to whom the booking has been delegated
2: travel intermediaries include travel agents, corporate planners, travel wholesalers, convention and visitor bureaus etc.
3: sister technologies such as corporate intranets and extranets are included here
4: electronic bookings can be made from any computer device including a PC, kiosk, ASCII terminal, WebTV, etc

Source: Connolly et al (1998)

Yield/Revenue Management (YM)

Yield management (YM) systems or revenue optimisation systems came to the hospitality industry via the airline sector where high-tech solutions for forecasting based on complex algorithms have generated tremendous improvements on managing capacity and rates for maximising yield. But for yield management to become truly effective in the hotel industry, much more is required in terms of technology support and the interface between the ICT systems reality at the property level and the centralised, or external to the hotel, distribution channels (Sigala et al, 2001c).

Traditionally, hotels would set their rates seasonally and other than perhaps for a few special events, a hotel's rate structure was fairly static throughout each season. However, the advent of YM systems have exponentially changed the dynamics, the rate and inventory management functions became more complex and it is so common nowadays for a hotel chain to change its rates multiple times throughout the same day. By magnifying these changes by the number of hotels in a chain and the number of distribution channels used, the volume of rate changes that need to be maintained is in the thousands. Rate management should also consider the hundreds of pre-negotiated rates and numerous affinity rates offered to those who qualify. To maintain control over discounting, rate decisions were often made at the property level. Today, however, ICT capabilities and tools are transforming this implementation model.

Sigala et al (2001c) illustrated how ICT advances and capabilities have been transforming the practice and concept of YM. They provided examples of how the role of YM systems has immigrated from that of aiming at automating the YM process and the calculation of yield at the hotel unit level towards the model of multi-distribution channel YM, to central rooms management and one-to-one YM.

First, the proliferation of distribution channels as a result of the advent of Internet technologies has tremendously increased the complexity involved in managing yield and has created problems of rate integrity. So, it is usually the case that different rate and room inventories appear in different distribution channels. This however, may in turn alleviate consumers as well as make them lose trust in some channels in favour of others, or worse, customers will seek alternative options. As Connolly et al (1998) argued lack of rate integrity among channels increases customer anxiety with rate shopping and so guests are contacting multiple points in the distribution network for verifying the accuracy of rates quoted. However, the use of multiple channels to book a single reservation can add unnecessarily to the overhead of the booking process, because this excess shopping overtaxes the distribution channels by consuming valuable time and resources that could be devoted to selling versus validation.

In order to overcome these problems seamless integration between YM and the hotel distribution system has been suggested (Connolly et al, 1998; Sigala et al, 2001c; Connolly and Sigala, 2001). Indeed, integration of YM systems with the hotel distribution system offers several tools to revenue managers. Automated links between YM and reservation systems ensure that information on the books as well as historical data are accurately and timely fed into the yield management's optimisation process. After the YM system has calculated the appropriate forecasts, it can optimise the availability, determine the appropriate rates, and set the selling restrictions and recommended strategies in the reservation system. The rates must be shared with every channel in the distribution network, thus enabling equal access to travel agents, call centres reservation agents and Internet users alike. According to Connolly et al (1998) this real-time uploading of rates, availability and selling restrictions (i.e. seamless connectivity between hotel GDS and YM) should be an important function of the hotel distribution system function. Seamless connectivity also provides booking agents with the best possible rate available given a set of criteria at that moment in time, anywhere in the distribution system, and so the former can maximise yield until the last available room (Sigala et al, 2001c). As Graham (2000) argued network technologies allow the industry to effectively distribute and sell distress inventory rather than let it perish. Thus, technology allows hotels to sell to a market that heretofore has been difficult to identify and reach, e.g. the extreme last minute decision makers, the highly price sensitive or guests that wants to bid for hotel rooms.

Contrary to the provision of a single image room and rate inventory to all distribution channels, some hoteliers are manipulating YM in order to direct reservations through the most economical channels, e.g. by offering discounts through certain channels (e.g. Internet). This approach works as long as all channel operators/users and the customers themselves know what they must do to find and secure the best possible fares or rates. Moreover, in order to offset the negative image that different rates in different channels may cause, many hotel companies have introduced "best available rates" programmes whereby the rates quoted at any time are the lowest possible for which that guest qualifies at the time of the request. However, as one approach is not necessarily better than the other, each hotel company must set its strategy and understand and manage its consequences.

Network technologies have also challenged the level of YM implementation in terms of where YM decisions are taken (Sigala et al, 2001c). Connolly et al (1998) claimed that the main issue when looking at rates and availability of information are where this information should be stored and where control over the master books should be maintained – at the property or at some central location. Traditionally, this control has been held at the local or property level. Earlier though, Hensdill (1997) suggested that with the trend of single imaging, centralised inventory management is the logical approach since it provides a single point for rate dissemination. She so envisaged a centralised YM that mainly referred to centralised processing and management of room and rates inventories. Yet, the implications of a centralised YM that Hensdill (1997) envisaged are more far-reaching than she implied, as hotel chains implementing a centralise YM approach are also capable of yielding by city or region versus by a hotel property only.

Indeed, in an effort to address the problem of room and rate integrity, hotel chains are increasingly transferring the practice of YM from property level to chain level (Connolly, 1999) by favouring a more centralised approach, with input and override capabilities from the local level. Sigala et al (2001c) argued that the tendency towards centralised management and control of multi-unit hospitality units also leads to the concept of central rooms management (RM). According to Bennett (2000) central RM occurs where the revenue analyses of all market segments for a given group of hotels are performed at one central site, not at the individual property level. Central RM can have the following advantages (Sigala et al, 2001c). It considerably decreases the maintenance and software costs as well as creates a central focus for a successful single-image system. At the same time, in a highly competitive environment where brand differentiation becomes critical, hotel companies must ensure that their pricing philosophies are consistent across the range of brands. Central RM puts "*this in the hands of one department and possibly one place, not in the hands of dozens or even hundreds of individual revenue managers across vast geographical distances*" (Sigala et al, 2001c, p. 369). Hotel chains can now also manage yield across a geographical area and not just at the property level. Moreover, as a dizzying number of new and alternative distribution channels arrives on the scene, central RM may position an organisation to control those channels better and to respond to them in the most profitable way for the brand as a whole. Sigala et al (2001c) also envisaged that very soon, central RM systems would be more accessible to mid-level and smaller chains, as the application service providers (ASP) model, or the single-image inventory, becomes more prevalent across the hospitality industry.

For the provision of central RM, several reservation provision companies are moving towards co-operation with YM system vendors (Hotel-online.com, 2000). For example, Integrated Decisions and Systems Inc. (IdeaS) are promoting their 'e-yield™' software (http://www.idealyield.com/solutions_n.html), which provides a network YM solution across a LAN, WAN or the Internet, indeed anywhere a group of properties or a worldwide chain require it. In the near future 'e-yield™' will also deliver benefits such as on-line pricing and availability and will integrate directly into a hotel or chain's Internet marketing and distribution capabilities. Dynamic or real time YM pricing models, whereby rates are dynamically changing, have also been proposed (Davis and Meyer, 1998). These in fact reflect the nature of the emergent patterns of online customer purchasing behaviour, e.g. online auctions and bidding.

The practice of YM by distribution channel or by region/city requires changes regarding data collection and analysis. When implementing the former, "*demand is not analysed by market segments rather, it is analysed at a finer level of analysis concerned with the purchasing behaviour of different segments through different distribution channels against the demand conditions of properties in different locations operating under different brands*" Sigala et al (2001c, p. 370). Demand is also required to be forecast for each distribution channel, hotel brand and location, so that the YM practice can direct sales towards the most profitable and least expensive channels, facilitate the cross and up selling of amongst locations and/or brands.

Sigala et al (2001c) also argued that the increased practice of CRM activities and database marketing have also led to a general business concept called 1:1 YM™. What distinguishes 1:1 YM™ from traditional YM is the focus on the specifics of an individual customer's situation and the value of the overall customer relationship versus focusing on general customer segments and the value of a specific customer's discrete transactions (Karadjov and Hornick, 2000). Traditionally the optimisation process considered the value of each transaction as a customer requests it. So, the value is usually taken to be the revenue or, in more sophisticated models, the contribution generated by that transaction. That means that a typical YM model is oblivious to the characteristics of the customer, and views the sale only as a price or contribution typical of the segment they represent. On the other hand, 1:1 YM™ brings one-to-one marketing and YM techniques together at the point of contact with each customer. It informs the price or availability decision with an insight into who the customer is, what the specifics of their current situation are and what is the overall value of their relationship (Sigala et al, 2001c). Hence, a hotel manager may decide to set aside rooms for high-value, long-term customers who stay often or generate significant ancillary revenue at a particular property or with other properties from the same chain. These decisions may involve complex tradeoffs between present revenue contribution and potential future business. 1:1 YM™ was also suggested as a solution to the increased commoditisation (i.e. sales based on price only) of the hotel products featured by several infomediaries on the Web, e.g. priceline.com, lastminute.com, Ebay.com (IHRA 2000), because it can enable the industry to personalise and differentiate its products and services.

Orkin (2000) argued that 1:1 YM™ cannot be implemented with property-based system because it needs to manage yield on the total customer history and all ancillary spending and thus, the practice of a central YM concept is required. He also argued that 1:1 YM™ evaluation cannot rely on traditional YM metrics that are based on profit enhancement. New control and evaluation systems should address both the issue of the customer's lifetime value and customer loyalty, as well as their importance to hotel revenue. Sigala et al (2001c) added that incentives would also have to align with such changes because as the hotel's 1:1 YM™ culture is based on understanding customer needs and reinforcing customer relationships, all customer-facing processes and contact-points would have to be redefined and employees rewarded for assisting in customer data collection and customer needs fulfilment. This in turn highlights the need for integrating different customer touch points (e.g. call centres, CRS, Internet etc) with YM systems, customer databases and reservations systems, which in turn leads to the consideration of a hotel ICT infrastructure that is centred around a hotel-wide customer database.

Trends and issues in marketing and sales ICT applications

Overall, the previous analysis has clearly analysed the interdependent role and relationships among all marketing and sales ICT applications and other systems as well as the efficiency and effectiveness effect that systems integration and information exploitation can accrue. It is also made evident that enhanced marketing and sales ICT applications nowadays require increased levels of systems integration among all ICT found primarily in the marketing and sales area but also in other hotel departments, e.g. F&B. In fact, an ideal ICT application infrastructure in the hotel of the future will be centred around a hotel-wide customer database.

To illustrate the increased systems integration, Connolly et al (1998, p. 28) proposed the concept of GDS for the hotel industry defined as "*the collection of systems, technology, telecommunications people and strategies that when coupled together provide an effective means of marketing and selling a hotel's guestrooms and facilities*". In brief, an hotel GDS is seen as a system with multi-faced dimensions reflecting the interfacing between several technologies (e.g. customer databases, marketing systems, YM systems, booking engines, Internet/Intranet/Extranet systems, airline GDS, interactive advertising and directories, statistical tracking and reporting systems) that automate the entire booking process, while its success depends on seven key factors: seamless connectivity, speed, reliability, accuracy, flexibility, cost and functionality (Connolly et al, 1998). Emmer et al (1993) had previously referred to such a system as the global distribution network. Based on the fact that hotels in the future should be customer-focused aiming at bringing the right product, at the right price and at the right place to the right person the following diagram (Figure 7.4.3.6.e) is proposed to illustrate the infrastructure and content of an effective hotel GDS system.

Figure 7.4.3.6.e Configuration and architecture of a customer centre hotel GDS

The focal point of the hotel GDS is the guest information database indicating the need for hotels to migrate from functional oriented infrastructures to customer centred ICT and organisational architectures. Guest information goes beyond the basics of name, address, dates of stay and method of payment, to include also guest preferences and guest history. The layer around the hotel guest consists of ICT systems incorporating all relevant information that can serve guest needs and requirements during the guest life cycle (i.e. prior, while and after staying at the hotel), which could be hotel facilities information, hotel availability, special services and destination information. All these ICT systems interface with an outer layer of sales and marketing ICT systems. This bi-directional interface allows the exchange and update of information between systems in order to provide personalised services/products and experiences to hotel guests. Sales & marketing systems can include data mining and data warehouses systems, CRM systems, guest registration information, frequent guest programmes, automated direct marketing programmes, yield (revenue) management systems, travel agent (or other intermediary) relationship and offers etc. The latter interface with ICT systems at an outer layer that consists of the functions supporting the different hotel distribution channels e.g. search engine and query tools, statistical and reporting systems, travel agent commission and reporting, booking engine, billing payment and electronic banking etc. The different electronic channels available for a hotel property are illustrated at the last layer e.g. Internet/Extranet/Intranet, call centre and other telephony services, online service providers, Interface switches, airline GDS, interactive advertisements and directories etc. Some distribution channels used to provide their own distribution support services (e.g. payment, commission tracking etc) however it is envisioned that centralisation of these functions and then their interface to the different distribution channels can minimise work load and errors, enhance control and management practices and facilitate better decision making.

Interfaces among systems is crucially important for ensuring dissemination, collection and analysis of information that in turn can be used for:

- enhanced personalisation of services/products and customer experiences;
- better yield management control and management by distribution channel, by individual customer, by property or by city;
- effective marketing and sales activities;
- co-ordination and effective management of hotel distribution channels;
- enhanced team working, co-operation between staff between departments and highlighting the interdependencies between hotel departments for achieving customer satisfaction and hotel performance;
- the development of a customer focus organisational culture and structure;
- fostering flexible working for better utilisation of human resources.

7.4.3.7 Electronic-point-of sale-system (EPOS)

Electronic-point-of-sale-system (EPOS) technology tools represent the core catering ICT applications and are the devices used to take and manage customers' orders. EPOS perform such functions as guest check control, communication between servers and the kitchen and sales data tabulation. An EPOS system is made up of a number of terminals that typically interface to a remote central processing unit. When the main processor of the EPOS system interfaces to a PMS, data can be directly transferred to various front office and back office PMS modules for further processing. Back-office systems provide the food cost analysis, labour scheduling and financial and inventory controls required at the store level. PMS interface accomplishes the basic objectives of electronic data handling, reduces errors and saves time. Recent trends identified have shown EPOS technology moving away from traditional keyboards and display screens to "touch screen" terminals and magnetic strip card readers. These innovations are changing the way in which customer transactions are settled.

EPOS are used by restaurant operators to improve work efficiency, enhance customer service and to save time, money and other resources (David, Grabski and Kasavana, 1996; Van Hoof, Verbeeten and Combrink, 1996). EPOS cannot solve all internal control problems in a restaurant environment by itself. However, if properly programmed and tied to back-of-house software, they can serve as a valuable tool that will provide management with the necessary information to make better decisions leading to increased profits (Durocher, 1997; Kasavana, 1995).

Today's EPOS are capable of much more than simple transaction management. In a simple case scenario, EPOS can improve customer service, enable staff to be more productive and provide opportunity for increased profits (Buergermeister, 2001). Some restaurants improve communications among employees and improve cost control by tracking the activities between the food preparation area and delivery to the customer. Kitchen staff can notify servers that food is ready for pick up and servers can notify bus-people that a table is ready to clear, which improves the efficiency of the meal service and makes it possible to increase revenue per seat-hour (Kimes et al, 1998). Systems also aim at boosting customer-service levels and at augmenting the number of services offered. To help restaurants reach new customers and retain existing ones, vendors blend third party software applications into EPOS and customer behaviour applications are among the programs that can help operators simplify integration of customer loyalty with EPOS technology (NRN, 1998). For example, Microstrategy develops database software programs that help companies collect and study sales data from EPOS in order to identify which products sell well and who buys them (Buergermeister, 2001). Overall, improved service quality, enhanced profitability and efficiency, integration of departments, faster communications and reduced costs often occur (Reid and Sandlers, 1992; Chervenak, 1993). Indeed, David et al (1996) revealed that EPOS systems provide significant increases in productivity according to the nine hotel chains included in their study.

Reasonable expectations for an EPOS system include (Buergermeister, 2001):

- consolidated reports leading to improved forecasting ability;
- improved guest service through accurate order entry;
- multiple settlement options and guest check splitting;
- increased speed of service;
- enhanced staff efficiency through improved communications.

7.4.3.8 Catering Information Systems

Apart from the EPOS several other ICT applications are used for automating many other functions in the operation and management of a food service establishment. The totally of these systems has been referred to as Catering Information Systems (CIS) and defined as a simple set of procedures enabling a catering manager to keep track of provisions and the money which those provisions represent (Gamble and Kipps, 1983). In a small catering operation this might not be difficult, since the number of meals being prepared and so the number of recipes and ingredients being used can be small. In this case, when the price of an ingredient increases, it is easy and quick to work out how this will affect recipes' costs, as well as to plan the amount of ingredients needed for each meal and to work out what it will cost to produce meals. However, when a kitchen(s) is (are) working with a large number of recipes, then hundreds of ingredients have to be purchased, stored, issued and controlled, while a price change of one ingredient may impact the cost of several recipes. To manage production costs new prices should be calculated and the right quantities of ingredients should be ordered and kept. If procurement is not sufficient, food quality could suffer while large procurement can result in ingredient waste and cost increases.

To manage these catering operations more efficiently the following ICT applications are available. Purchasing and inventory control systems track the items on order, details of suppliers, inventory on-hand and minimum par level so that ordering can be automated. Menu and recipe management software that creates files for each recipe and menu item permit the analysis of the impacts of changes of ingredient costs, ingredient quantities and price changes. Food costs percentages can be calculated with these systems that are used for pre-costing menus and events. According to Gamble and Kipps (1983) CIS should not be considered and applied as a standard stock control system but rather exploited based on one principle, i.e. that the point of control in a catering business is not the storeroom but the standard recipe. This is because what matters is not how many loaves of bread are in stores but how many loaves should be in stores, based on what has been ordered and which dishes have been sold.

Although there are separate CIS systems handling these functions their integration with EPOS and PMS is crucially important for enhancing operations' efficiency and effectiveness. This is because interfaces can streamline the whole process by allowing perpetual inventory of food ingredients to be kept in the following way (Sheldon, 1997). When the sale of an item is registered in the EPOS, its component ingredients can be calculated and transmitted to the CIS where the food inventory amount is subtracted from the quantity on hand. Multi-unit restaurants require additional interfaces so that data can be shared between units and from each unit to head office. Data communication between units allows everybody to benefit from the others' experience, while data communications between units and head office allow for online consolidation of sales and financial reports as well as centralised procurement. Indeed, as Gamble and Kipps's (1983) illustrated (Figure 7.4.3.8.a) CIS can support all types of catering operations from operational to strategic tasks.

Figure 7.4.3.8.a Features of a CIS at different levels

Level 1

- Maintains a file of up to 1000 ingredients
- Maintain a file of up to 1500 recipe
    - Each recipe may contain up to 15 ingredients
    - Each ingredient may be another recipe
    - Various units of quantity or volume may be used
- Sorts out the recipes and ingredients as required
- Finds combinations of recipes to produce meals of a given price
- Print reports to show the effect of ingredient cost changes on recipes
- Automatic recipe repricing with manual over ride if required (individual gross margins my be assigned to each recipe)
- Files up to 100 requisitions, each of which can contain 50 dishes

When printing a requisition the CIS will show:
The menu pre-cost at current costs, i.e. the planned production cost, each recipe's ingredient quantities in metric and imperial weights, the stores requisition or the inventory issue list

Level 2

- At a glance inventory control on the main stores
- Day-by-day inventory control on up to 6 kitchens
- Audit trail of direct adjustments to stock
- Outstanding orders – progress chasing
- Automatic cost adjustments as deliveries are entered
- Control of inter-kitchen transfers
- Stock reconciliation reports
- Dead stock reports
- Dynamic re-order point adjustment for ingredients
- Historic, current or weighted mean costing options for ingredients

Level 3

- Current week and year-to-date actual vs potential sales reports
- Detailed analysis of variances actual vs potential costs
- Market price indices
- Dead recipe reports
- Detailed history of planned recipe sales

Source: Gamble and Kipps (1983)

The impact of CIS on costs and revenues is evident. Gamble and Kipps (1983) reported that a hospital reduced its budget for materials for 20%, improved its cost recovery against food sales by 12% and reduced its average inventory holding in kitchen stocks alone by £200. CIS can also improve food quality and consistency and lead to improved and enhanced work environment and tasks for catering staff, as they enable both managers and operations staff to divest themselves of repetitive and boring jobs and release the time and effort previously devoted for pricing decisions and stock controls to new value added tasks. So, managers become free to manage, need not spend too much time rechecking figures and producing reports, but their time can be more effectively used for planning and control.

7.4.3.9 Conference management ICT applications

A conference manager requires an ICT application to help him/her with the booking, co-ordination and execution of conferences, meetings, and events of all kinds from initial enquiry, through quotation, detailed planning and information dissemination, to invoicing and full accounts. Thus, a typical conference management ICT system might have the following main spheres of operation (Braham, 1988, p. 153):

- enquiries: a rolling diary of events is maintained with on-line enquiry facilities covering room availability within certain dates or date availability for certain rooms in order to respond effectively to conference inquires;
- conference diary: it permits full control to be exercised over the total number of conferences booked into the establishment, it holds historical data well as conferences booked many years in advance;
- staff organisation, e.g. staff rotas and allocation to tasks, job scheduling;
- function list: it produces function lists and departmental function sheets to give detailed reporting for each department, e.g. the kitchen, dispense bar, florist etc;
- quotation and sales forecasting: it enables the track of data and development of reports regarding quotations of conferences and banquets, internal costs, sales persons' commission as well as forecasting;
- bookings: single booking entries for events that span more than one day which reduces the necessary input time, facilities booking, e.g. visual equipment etc;
- market research database;
- marketing and mailing and their interface with word processing for brochure mailing and personalised letter production and mailing;
- invoicing, sales ledger and reporting, creation of customised reports.

7.4.3.10 Back office computerised accounts

The organisation of accounts forms a major part of their usage in a very large number of hotels. Indeed in these days where cash-flow is so vital to the survival of a firm, the capability of handling accounts and to achieve swift results is essential from the very smallest business upwards. Thus, a comprehensive back office financial accounting system specifically designed for the hotel is vital to the smooth operation of establishments. Basically, it will be designed to automate and reduce the time consuming back office accounting functions, whilst having the versatility to allow the processing and storage of irregular transactions if required. The financial accounting program includes purchase ledger and general ledger modules that quickly and efficiently process back office functions and automatically generate the hotel management reports needed for effective decision-making. Although, the accounting applications that can be handled by computer are numerous, a typical overall package would include the following (Braham, 1988, p. 157): purchase ledger, general ledger, balance sheet, profit and loss reports, management information, financial modelling, sales ledger, budgeting and forecasting, night audit, payroll.

7.4.3.11 Telephone systems

Many of the current capabilities of telephone systems are due to the sophistication of the computerised Private Automatic Branch exchange (PABX) switchboards, that usually have a call accounting system (CAS) that has (Braham, 1988, p.171): handling of direct-distance dialling; automatic route selection, i.e. automating identification of outward dialling; least cost routing, i.e. distribution of calls through a least-cost routine; and call rating program, i.e. pricing of outgoing calls. Thus, CAS can significantly simplify the sequence involved in call placement. Guests can direct-distance dial, thereby eliminating operator intervention. The automatic identification of outward dialling feature of a CAS also immediately identifies the extension from which a call is placed. Because how a call is routed significantly determines its cost, the automatic call accounting system with a least cost routing can identify and direct calls over the least-cost available line, regardless of carrier. A carrier is defined as any recognised entity that transmits messages or other communication for general use at accepted rates (Kasavana, 1987). When the line is busy, then the least cost routing system instantly prompts the system to seek out the next least expensive line. Thus, CAS could significantly enhance management's control of expenses relating to local and long-distance telephone-services as well as provide a basis for profitability.

A call accounting system can operate as a stand-alone system or may interface to the PMS. When a CAS is interfaced to a PMS front office guest accounting module, telephone charges can be posted immediately to the proper guest folio. Sometimes telephonists also need to locate guests and establish whether they are actually currently resident in the hotel or not. It is therefore essential that they have the facility to look up guests by their name, room number, company name and group name. They must have an overview of all reservations as well as check-outs so that they can quickly establish the location of a particular guest or guests. For these reasons, a PMS interface with the telephone system is required in order to offer the following functions: easy enquiry (guest name and room number); guest look-up (past, present, future detail information); in-house guest lists; messages may be entered in guest "comments" field (Braham, 1988, p. 174). Overall, (Kasavana, 1987) summarised the benefits of a CAS/PMS interface as follows:

- Enhanced guest services (e.g. wake up calls, billing inquires, forward messages);
- Improved communications networking;
- Improved call pricing methods;
- Minimised telephone traffic expenses;
- Automatic charge posting to guest folios;
- Automatic call detail records;
- Detailed daily reports of telephone transactions.

Since the CAS reduces operator intervention, the hotel telephone department can save both time and labour. In addition, elimination of telephone meter readings and guest telephone charge discrepancies contributes to faster check-out times and more efficient front desk operation. Braham (1988, p. 171) argued that hoteliers' are using their in-house telephone systems much more effectively by also linking them into energy management, fire alarm and video check-out systems. Thus, overall the major reasons for using a telephone management system are to: provide a profitable telephone service to guests; control administration use of the telephone system; analyse exchange and operator efficiency; assist with room management.

7.4.3.12 Security: electronic door lock systems

Security in its widest sense is of major importance to caterers and hoteliers, especially as it has become accepted that guests have a right to feel as secure in their hotel bedroom as they would at home (Braham, 1988, p. 183). On the other hand, think tanks organised by IHRA (1998 and 1999) identified security as a major issue that guest look at when selecting a hotel. Particularly, after the September 11th 2001 events in New York, security issues have risen in importance for hoteliers and guests.

Members of the e-business committee of the American Hotel & Lodging Association (AH&LA) (anonymous, 2001c) claimed that guest security is the new frontier for e-business in the hotel industry in the wake of the September 11th 2001 events in New York. To that end, more and more hotel companies would be looking to "state of the art" guest recognition and security technologies (e.g. fingerprint identification and Iris scans) to strengthen guest security, while the Internet would provide a mean to access central data repositories centrally stored by corporate and governmental entities.

Computerised fire-protection systems satisfy most of the elementary requirements of fire precautions such as: provide detection and notification of a fire; alert guests to the best means of escape; provide the guests with the maximum time to escape; help where possible with extinguishing the fire. A computerised fire system is in many cases also part of a wider security system handling both fire and intruder alarms, as well as energy management applications. It is unlikely that a fire system will be exclusively used for fire precautions (Braham, p. 187).

Computerised or electronic door locking systems (e-lock system) replaces traditional brass keys and mechanical locks with sophisticated computer based guest room access devices. E-lock systems provide in-room security for guests and their property as well as save hotels from costs incurred from lost keys. Kasavana (1987) identified two categories of e-locking systems namely hard-wire systems and micro-fitted systems.

Hard-wire e-lock systems operate through a centralised master code console, which is interfaced to every controlled guest room door. The console may be a slotted switchboard centrally located at the front desk. With this type of hard-wired system a front desk employee follows a check in procedure by inserting a previously encoded key/card into the proper room location slot on the console. The console immediately transmits the key/card's code to the remote guest room door lock. By the time the guest leaves the front desks, the key/card which he/she has been issued is the only workable guest room access key. Key/cards issued to previous guests who occupied the same room become invalid. Because every controlled door must be cabled and connected to the master console, hard-wired systems are both expensive but also difficult to implement, for example because of legacy and systems integration problems, or problems having to do with hotel design and construction. The evolution of hard-wired e-lock systems has seen them integrated with in room guest services, e.g. TV services start as soon as the guest first enters his/her room greeting him in the property, lights go on (ENM) etc. Once again, system integration has allowed personalisation of hotel room services.

On the other hand, micro-fitted e-lock systems operate as individually configured stand-alone units, thus avoiding the complex, dedicated circuitry required by hard-wired locking systems. Each door has its own microprocessor which contains a unique, predetermined sequence of codes. A master console at the front desk contains a record of all code sequences for each door. With a micro fitted locking system, the front desk employee completes guest check-in by encoding a key/card with the next code in the predetermined sequence of codes for an assigned room. The front desk console and the microprocessors of controlled doors are essentially separate units. What connects them is the predetermined sequence of codes for an assigned room. This means that the front desk console must not only be programmed with the same predetermined codes that is contained in the micro processor, but also that the console and each micro processor must agree on which code in a sequence is currently valid. However, for different reason the latter may not happen and problems arise. In this case, key/cards would need to be reprogrammed and sequenced with a new code that agrees with that of the master console.

Other functionality of the e-lock systems may include:
- the development of various levels of master keys, e.g. one for housekeeping employees, another for security officers and/or for property management officials;
- a "do not disturb" option for guests; this option typically employs an indicator which displays a notice when the guest wishes privacy and is typically displayed as a flashing red light located within the locking mechanism when a room attendant inserts a key/card;
- a safety features preventing the door from opening while a key/card is forgotten into the door (provided by a time control mechanism); this prevents guests entering a room while forgetting to take the key/card or of others entering the room when the guests leaves with the key/card remaining in the door;
- the maintenance of an audit trail of all activities involving the use of system-issued key/cards. Some systems print reports detailing activities in their chronological sequence. Other systems record and store activity data which can be formatted to provide printed reports on demand. These reports have valuable implications for management decision making, e.g. how long do housekeeping spend cleaning a room, how long do guest spend in their rooms and during what times (e.g. for marketing or property maintenance scheduling activities).

E-locking systems have become an essential hotel feature nowadays not only for security reasons but also because of the use of self-service terminals which enable unassisted guest check-in and check out to become more prevalent through out the lodging industry. Nowadays, smart cards have been embedded into e-lock systems so that the latter can act as a guest folios whereby guest can charge to their account anything they purchase from hotel departments. The storage of personal data on e-lock systems with smart cards may also provide extra personalisation of guest products and services (e.g. smart cards may hold information regarding the guest required room temperature and interface with ENM for controlling this) as well as tighter security controls (e.g. the identification of the person who enters a door (of course as elsewhere privacy and security concerns may prevent or delay some functionalities). Enabled by the Bluetooth technology, e-lock systems are also going wireless (Ronson, 2001), which is an easier and less costly system implementation option for old properties.

7.4.3.13 Smart cards
Smart cards store information on an integrated microprocessor chip located within the body of the card. A great variety of information can be stored from monetary and value used for retail and vending machines, to secure information and applications for higher-end operations such as medical/healthcare records. Moreover, new information and applications can be also later added into smart cards depending on the chip capabilities. The most significant development of smart cards in hospitality was back in a 1997 trial sponsored by IBM, America Express and Hilton Hotels Corporation (Cline and Warner, 1999). American Express and Hilton issued cards to select a group of frequent travellers and participating card-members. In addition to serving their existing card functions, smart cards were used to conduct unique travel-related

interactions with kiosks in eight Hilton hotels in major US business travel destinations. The American Express/Hilton smart cards retained their usual payment functionality, but offered additional, non-payment related features including kiosks-based room selection, room key issuance, bill review and receipt printing and the ability to change preferences and profile information. However, most smart cards nowadays function exclusively as payment vehicles.

7.4.3.14 Videoconferencing systems

Videoconferencing has been defined as the interconnection of two or more locations electronically using telecommunication links such as fibre optic links, microwave or satellite transmission (Sheldon, 1997). Depending on the number of senders and receivers of information, two types of videoconferencing are identified namely point-to-point (one sender and one receiver) and point-to-multipoint (one sender and multiple receivers located in different places) videoconferencing. Videoconferencing facilities in hotels serve the needs of their business and meeting travellers. With this feature hotels can gain a new revenue source and attract more business travellers and meetings while guests can enjoy low-cost, high quality communication and meetings with anywhere in the world. In particularly, point-to-multipoint videoconferencing available in several hotels being part of the same hotel chain can be a major tool for enhancing brand loyalty among business travellers.

However, videoconferencing presents both opportunities and threats for the hotel industry. The business travel sector is most likely to substitute videoconferencing for travel and this can be further supported by the decreasing telecommunication costs, the wide adoption and familiarity with ICT or even certain events such as the threat of travelling created by terrorist attacks e.g. those in September 11. However, Sheldon (1997) identified three reasons for which videoconferencing cannot replace all business meetings: 1) many employees like the travel opportunity that business trips and conferences provide; 2) business trips often accomplish more than one goal, e.g. attend a conference and visit a client in one trip; 3) the personal contact and networking provided by face to face meetings is invaluable in many business situations and videoconferencing can never provide it.

7.4.3.15 Energy management system (ENM)

An energy management system (ENM) is a computer-based control system designed automatically to manage the operation of mechanical equipment in a property (Kasavana, 1987). The programming of this system enables management to determine when equipment is to be turned on and off, or otherwise regulated. ENM typically provides rapid access to heat, ventilation, lighting and air conditioning levels at remote locations and display these readings on central console screens. Kirk (1987) added that ENM can also be used to provide a comprehensive building management system controlling also electrical load management, security and fire safety. He also added that the objective of ENM is to minimise energy costs whilst optimising comfort levels for guests and employees in the building. ENM may also provide data on the levels of consumption of fuels and on the efficiency of the plant. In many cases, energy cost savings are tracked by an in-house micro-computer through specially created electronic spreadsheets. In summary, Kirk (1987) argued that ICT can directly and/or indirectly be used in order to implement the following objectives of an energy management programme:

1. reducing heat loss to a minimum;

2. balancing heating and cooling loads to the duties required;
3. optimisation of the operating periods of the system and equipment;
4. maintenance of equipment at optimum efficiency;
5. recovery of wasted heat;
6. monitoring and analysis of energy consumption;
7. the education and training of staff towards the efficient use of energy.

When ENM are integrated with other systems (e.g. check-in function of the front office system, automated check-in/out kiosks, e-lock systems) then mechanical equipment can be regulated to start and stop operating depending on whether the guest is in room or not. Future developments of ENM have envisaged the integration and synergy between ENM, guest databases and biometric technologies so that lighting, water and room temperature can be controlled at the particular individual preferences that would have previously been stored in databases (i.e. allowing enhanced product personalisation and informalisation).

7.4.3.16 In room ICT applications

There are two reasons for the provision of in-room ICT applications: a) the provision of a service that attracts the more lucrative business guests and the development of his/her loyalty; and b) the development of further revenue earning opportunities that attract the guest to spend over and above the room charge. Moreover, in room amenities can promote the use of other hotel facilities and services (e.g. restaurant, gym etc), while on the other hand, hotels can gain extra revenue from ISPs, portals and other .com businesses by advertising them in their in-room services, e.g. hotel TV channels, hotel internet portal. The following in room ICT applications can be found.

Television services

An assortment of guest-operated services through the TV provide information services by accessing certain types of PMS data or by displaying information from specifically created guest information files. So when a TV is integrated to the PMS and specifically to the guest accounting module, guests are able to access folio data and are provided with means by which to approve and settle their accounts. Folio copies are afterwards available for guests to pick up at the front desk. Apart from check out, billing inquiries, guests can also use their TV sets for voice message retrieval, as well as local and general information retrieval (e.g. ordering of flowers), which can reduce the work that reception and concierge staff may have to do. In this vein, TV sets act as guest information services whereby guests can access information about the hotel, outlets, surrounding attractions, airline schedules, stock market reports, video games etc via connections to cable broadcast systems, wire news services, or other external computer systems. Instead of bothering with systems interconnections, TV sets nowadays provide easy access to Internet and email services and guests can find any information they want by surfing the web (Ronson, 2001).

TV sets are also used for in room video and game services. These can be interfaced to a hotel's PMS or they can function as independent. The PMS interface includes a timing device and so after the dedicated TV pay channel has been tuned in for a predetermined amount of time, the device triggers automatic charge posting to the appropriate guest folio. In the case of stand-alone systems, the guest has to request the pay channel to be turned on, staff member has then responsibility for posting the charge to the proper guest folio manually which might creates work and maybe errors.

In room Internet access

Cline (2001) predicted that within the next few years, any hotel – ranging from limited-service establishment to five-star luxury properties – that does not offer high-speed Internet access in every guestroom would be at a severe competitive disadvantage. IH&RA (1999) reported that it is no longer a question of whether or not to provide in-room Internet access (this is given), but the question is how to provide it in a cost effective manner while continuing to make a profit at the same time. Revolutionary applications have seen hotel chains building in-room Internet guest portals integrated to guest databases in order to provide guests the possibility to configure and personalise the interface as well as be able to have the same interface in whichever property of the same hotel chain they log on again.

Mini-bars or in-room refreshment centre

Automated mini-bars are capable of monitoring sales transactions and determining inventory replenishment quantities. Kasavana (1987) identified two categories of mini-bars namely the non-automated honour bars and the microprocessor based vending machines. Non-automated honour bars typically involve stocks of items which are held in both dry and cold storage areas within a guest room. Changes in the bar's opening inventory level are noted either by housekeeping room attendants during their normal rounds or by designated room service employees. Thus, non-automated honour bars may pose several problems for the hotel, e.g. consumption is almost impossible to regulate accurately since the bar is always open as well as frequent late charges, after the guest has left, may arise. They also request high labour work load and cost associated with taking physical inventories and charging guest folios. Microprocessor based vending machines contain food and beverage items with fiber optic sensors that record the removal of stored products. Once triggered, the sensor relays the transaction to a micro-processor, which in turn through a computer interface transfers and stores the recorded transactions in to a computer. The latter converts transactions into accounting entries, and relays them to the PMS guest accounting module for folio posting. The bar system's computer also maintains perpetual inventory replenishment data which directs the restocking of vending units.

Mini-bars have been provided in hotels for many years. The reason for their existence has always been either to stimulate extra sales to guests or to replace traditional room service. Computerised mini-bars provide an instant beverage and light snack room service for guests whilst allowing room service staff, where they still exist, to be deployed solely for the provision of larger and more profitable orders. Thus, mini-bars can create satisfied customers providing them an extra service while generating extra revenue for the hotel that might not otherwise have been spent.

Finally, research has shown that business and holiday travellers spend a lot of time in their rooms, working or just unwinding, while female business travellers are reluctant to go to the hotel lounge unaccompanied (Cline and Warner, 1999). In-room entertainment and nowadays, in-room Internet and other office facilities are being used deliberately to encourage guests to spend longer in their rooms and the mini-bar is one of the sources of revenue targeted with the former. It is the synergetic effect of all these in-room systems to room revenue that can be the incentive to offer more or even free in-room amenities.

7.4.3.17 Purchases and procurement: e-Procurement

The hospitality industry has historically struggled under the weight of fragmented supply chains, made even more unwieldy by complex and inefficient business processes in distribution and procurement. Rothfeld (18/2/2000) identified the following shortcomings of the traditional procurement environment: it is very laborious; manually processed which increases errors; unable to control and track costs; it lacks of negotiated pricing and authority control; it has extended cycle times; and it is reactive rather than pro-active. On the other hand, by moving procurement and distribution processes on the Internet (e-Procurement) hospitality firms can improve both ends of the equation, i.e. reduce costs, generate new revenue streams and improve audit control. By contrasting the model of procurement in the old and new economy, Table 7.4.3.17.a highlights the benefits of e-procurement.

Table 7.4.3.17.a Procurement benefits created by the shifts to e-commerce

Old economy	New economy
Supplier-centric	Buyer-centric
Long term contracts	Dynamic pricing
Outdated buyer guides	Real-time information
Local sourcing	Global sourcing
Hierarchical searching	Universal searching
Phone, fax-based communications	Web-based communications
Inventory overcapacity	Reduced inventory
Fragmented buys	Aggregated buys
Paper trail	Paperless or digital trail
Manual tracking	Automatic tracking
Expensive, proprietary legacy systems	Inexpensive, open extranet systems

Source: aviationx.com

E-Procurement basically streamlines the procurement and delivery processes (from demand to supply and back to demand) by integrating them into an Internet based platform. Oliva (20001) defined the integration offered by e-procurement as a system where each aspect of the purchasing process is done electronically – from the department head ordering the product to the payment being pulled from the hotel's bank at the point of sale. In this vein, e-procurement promises to end the hurdles of an inefficient buying system with cost controls, fully automated order processing and corporate power to require properties to be 100% compliant with purchasing habits.

E-Procurement is a direct result of the Internet's capability to deliver information permanently in a common format to any computer, to share information from many sources (e.g. customers, financial institutions and suppliers). The Internet also simplifies the process for the end-user as well as it reduces infrastructure and transaction costs, as it is a common shared platform, meaning that businesses of any size can gain access for a variety of purposes. Indeed, in contrast to the traditional, expensive to implement and proprietary based Electronic Data Interchange (EDI) systems, the Internet marketplaces furnishing diverse products and services are breaking down trade barriers and offering access to hospitality companies of all sizes.

Overall, web-based procurement systems have the following advantages: electronic access to a global and varied community of suppliers; permanently one-stop shopping; specific and dynamic product pricing; detailed purchasing reports and purchases' authorisation control system; just in time delivery of products; efficient automated paperless ordering process; assurance of chain approved purchases for brand consistency and good customer service between affiliated hotels; enhanced control by the corporate office, e.g. in terms of goods quality, consumption and cost by property by sending reports to the corporate office comparing properties purchasing volumes and patterns; and tremendous financial benefits. In fact, financial benefits are a result of several effects that e-Procurement can have on functions and processes. Specifically, e-Procurement facilitates and improve processes by (Ngonzi, 2000):

- Search and storage of huge databases and information about suppliers;
- Aggregation of small purchases to make the order process more cost effective;
- Minimizing the need for intermediaries between the supplier and buyer;
- Competitive and dynamic pricing;
- Ability to customise marketplaces, which in turn minimises search costs through vendor-specific interfaces to facilitate vendor comparison;
- Consolidated reporting to monitor supply chain performance and budgeting;
- Single point of contact for customer care;
- Access to international distribution networks;
- Process improvements in handling purchase orders;
- Customised online order-flow-tracking capability that is based on a company's internal workflow routing process;
- Streamlined buyer and suppliers commerce processes;
- Shared network of commerce services;
- New methods of dynamic sourcing and trade;
- Aggregated purchasing and expanded sales channels;
- Extended customer reach and enhanced customer service;
- Meaningful tools to facilitate marketplace interaction;
- Reduction in lead times;
- Reduction in shrinkage and requirements for safety stocks;
- Minimisation of static inventories;
- Quick response to customer preferences;
- Reduction in paper pushing process;
- Improved accuracy of records in all inventory management activities;
- Facilitated vendor management and measurement process;
- Enhanced cycle counting program, leading to elimination of physical inventories;
- Reduced overhead/capital expenditures related to inventory storage requirements;
- Online financial profit and loss information to operations tied to purchases.

In brief, e-procurement benefits can be clustered into three categories: cost reduction; new revenue stream; and improved audit control (Table 7.4.3.17.b).

Table 7.4.3.17.b The potential of e-Procurement

Cost reduction	New revenue streams	Improved audit control
Procure more effectively and efficiently: • Streamline processes • Improve volume and price • Increase predictability	*Offer a service to the business community to resell:* • The process • The service and software • The volume discounts	*Ensure proper authority of purchasing:* • Profiles Purchasing levels Approval via work flow through next levels Being properly applied to area of responsibility • Better connectivity General ledger/ERP feeds
	Invert focus from cost savings: • Leverage income	

Source: Ngonzi, (2000)

Indeed, Ngonzi (2000) reported that costs savings from more efficient supply chain transactions are currently estimated to be at $3.5 billion to $4 billion in the United States alone, and $7 billion globally. According to Accenture's findings (in Oliva, 2001) at full integration, when broken down, a hotel that saves 10% using online purchasing will see 5% of that coming from price controls, 3% from standardisation of volume and quality of goods and 2% saved on the payment and, or integration.

All types of hotels (branded, managed and independent) can equally benefit from e-Procurement. Thus, branded hotels could:

- Leverage their relationships, experience, knowledge and purchasing power to re-engineer corporate purchasing efforts for improved efficiency;
- Develop (or partner with vendors and/or with competitors) private, secure, customised sites for employees to purchase products and services from approved vendors. This can then enable real time inventory management and accounting;
- Take control of the procurement process by minimizing "maverick" purchases and monitoring adherence to approved vendor lists and quality standards.

On the other hand, independents and management companies could:

- Gain access to rebates traditionally only available to larger companies based on aggregated demand;
- Increase their buying power;
- Leverage public access applications that provide access to extensive vendor networks and their products in horizontal or vertical marketplaces;
- Save labour costs by moving processes online.

However, there are several reason that actually slow down the hospitality industry from fully benefiting from eProcurement (Brown, 2000, Ngonzi, 2000):

- legacy systems and systems' integration and compatibility;
- bandwidth scalability and reliability issues associated with the Internet;
- resistance to changing procedures and learning new systems;
- the tremendous increase of the number of eProcurement marketplaces decreases the likelihood of an industry platform standard for e-commerce, which in turn reduces the ability of suppliers and buyers to interact on multiple platforms and potentially minimize cost savings.

Thus, in order fully to realise the benefits of e-Procurement, hospitality companies have to: integrate their overall business strategy with the eProcurement ecosystem; identify how current processes will be impacted; and integrate eProcurement systems with existing legacy back/front office systems.

Deutsche Bank (Brown, 2000) has currently estimated a $60 billion domestic and $100 billion international market for hospitality eProcurement, including furniture, fixtures and equipment (FF&E), renovation and construction, service contracts, operating supplies and F&B. Ngonzi (2000) reported that hospitality eProcurement of more than $20 billion domestically and $10 billion internationally is forecasted to be online in the next 12 to 18 months. Forrester Research (2000) reported that although North America will own half of all online sales in 2004, eBusiness in Western Europe will grow to $1.5 trillion, followed by Latin America, which is projected to reach $82 billion in 2004.

7.4.3.18 Executive Information Systems (EIS) & Decision Support Systems (DSS)

Executive Information Systems (EIS) also known as Decision Support Systems (DSS) or business intelligence provide management the ability to turn large amounts of operating statistics and property data transactions into consolidated information providing quicker insight into property productivity and profitability. For example, by using EIS management, businesses can get quicker and more accurate daily flashes, forecasting, payroll management and consolidated reporting.

EIS are argued to be essential to all types of properties (independent, corporate level owned and/or operated properties, multi- unit management companies) and at all levels (executives, general managers, operations managers and controllers), while EIS integration with other ICT applications is needed for getting consolidated information from each system (Pinkham, 2001). Indeed, the functionality of EIS is very dependent on the database architecture as well as on how many systems they will interface with and provide consolidated reporting. EIS are not meant to replace the functionally current back-office accounting or PMS modules, but have their own value. EIS can provide daily, weekly or even monthly transaction listings that will be audited and balanced as well as posted directly into general ledger (depending on how integrated their interfacing capabilities are). The major functionality of EIS from where benefits are expected include the following:

- Payroll: this is a biggest payoff area of EIS since payroll is the single largest expense. Managers have direct access to department payroll information daily and so can more effectively manage overtime and labour costs.
- Automation: night audit tasks can be automated with the vary little human intervention, reports can be distributed electronically for immediate viewing by everyone, while saving hundreds of payroll hours and copier charges annually.
- Productivity enhancements: providing timely, accurate, graphically visual information of property data and statistics.
- Forecasting and budgeting processes. Historical versus budget versus forecasted information is immediately available in EIS for general manager, executive or corporate level users in a very user friendly interface, i.e. by clicking on any graph or highlighted area they can drill down into the data they might need. Easy, accurate and immediate availability of information is claimed to make users feel a sense of responsibility and ownership while having a stake in the outcome of their business, before it is too late to react.

7.4.3.19 Human Resource Management ICT applications

The major ICT applications in HRM are for training purposes. Kasavana (1996, p. 41) identified three types of computer based training: a) drill and practice, which involve repetitive opportunity to pair stimuli with appropriate responses; b) tutorial and dialogue, whereby programmes carry the burden of instruction; and c) simulation and games that create an experience designed to give the illusion of reality. Most of these programmes can address a wide variety of human resource development and training such as interpersonal skills, management development, employee and client communications, customer services, sales/marketing techniques (Thomasson, 1994).

Computer-based training (CBT) has long been regarded as a successful and efficient learning tool. Many experts argue that the role of educational technology is to help improve the overall efficiency of the teacher/learning process. Efficiency can be manifested in a variety of ways, e.g. the quality of learning or the degree of mastery, the time taken for learners to achieve desired goals, numbers of trainees involved etc. Such benefits could be classified under three themes namely cost effectiveness, training effectiveness and learning effectiveness. Overall, CBT benefits are summarised as follows (Thomasson, 1994; Cleary, 1998; Harris 1993; Kasavana, 1999; Harris et al, 1993; Sigala et al, 1999; Christou and Sigala, 2000):

- *training has developed from teacher style training with flip boards and "chalk and talk" methods to offering advanced learning environments, training simulators and self-development programmes.* Interactive multimedia systems offered the capability to present complex training information in a single, dynamic, thought-provoking and cost effective delivery simulator. Moreover, by employing a range of different media within a computer learning environment, further advantages may accrue. As Blattner and Dannenberg (1992) point out, the senses that humans use to interact with the world enhance each other in various ways, adding synergies or further informational dimensions.
- *Multimedia training packages are capable of stimulating, engaging and motivating any work force, offer greater active learner participation by enabling companies to tailor corporate information to individual variances such as location, timing and people.* So, employees gain access to programmes that are delivered by onscreen narrators who are natives of their culture, deliver training in their language and present training that is based on their training levels. Because of the high interactivity of such products, users can also access information in a non-linear fashion, retrieve, replay any programme they want at any time, without any wear and tear of the delivery medium. Studies have revealed that multimedia has influenced levels of trainee participation, employee motivation, learner anxiety, the overall learning process by reducing training time, retention levels, quality of training and human error and stimulating senses in a more effective way. Furthermore, programmes can be made available at any place, e.g. home and at any time, e.g. according to the user convenience. Thus, travelling to training centres is minimised, as trainees can learn on site, which also means no travel and subsistence expenses or journey time and decreased labour absenteeism from work for training. Staff normally used for training can be released to perform other duties. Finally, multimedia are cost effective because once the application is purchased, it can be repeatedly used and because they can also measure the performance and effectiveness of both the trainee and the training package.
- *virtual classes through Web Based Training (WBT) or e-learning.* A distinctive advantage of the use of the Internet for training is that it can also support on-line real or non class discussion through the posting and answering of email or chat sessions that intend to provide trainees with classmate and instructor interaction. Instructor email invites trainees to submit questions, comments, concerns, or other issues directly to the instructor and most systems guarantee a rapid response rate of less than 24 hours. As hospitality and tourism companies begin to implement private Intranets, the application of e-learning becomes more appealing, as courseware can be hosted on a network server, constantly and easily updated and readily available to those authorised by the network administrator.

Concerning e-learning in particular, Sigala (2001c and 2001d) advocated the appropriateness and identified the benefits of e-learning specifically in tourism and hospitality as follows. Because of its features namely connectivity, interactivity and convergence, the Internet offers great flexibility to match the specific conditions of work within the tourism and hospitality sector. Potentially global in its opportunities for access, good e-learning is not time and place constrained (e.g. employees can be trained while remaining at the workplace), can foster collaborative learning by drawing on the expertise of all corporate staff as well as third parties wherever located. Collaborative learning also allows employees to experience multicultural diversity and teamwork by interacting online with people of different social and cultural background. The acquisition of social, multicultural and communication skills are of a crucial importance for employees working in the tourism and hospitality sector, because the inherently multi – national and -cultural tourism workplace (including both colleagues and customers) requires a knowledgeable workforce that can work collaboratively and serve a multicultural client irrespective of their spatial, time and cultural differences. E-learning acclimatizes staff to the changes occurring in the tourism and hospitality workplace, e.g. growth of e-business applications and increasing alliances and mergers among companies. E-learning also instils life long learning while fostering and supporting the creation of the learning organisation. As employee turnover is high, the time and cost to train and educate new recruits is a substantial and continuous investment. The delivery of training on the Web can reduce the cost and the time involved and so can help new hires be productive more quickly as well as reduce travel and programme development expenses.

Figure 7.4.3.19.a Applied multimedia for hospitality training

- **Front desk**

Tasks and concepts: Guest-registration status, room key distribution, communications with guests, concierge type information awareness, customer complaints

- **Maintenance engineering**

Tasks and concepts: electrical and environmental systems, equipment operation, safety procedures and emergency plans, facility information, purchasing

- **Housekeeping**

Tasks and concepts: room turnover procedures, laundry, equipment operation, chemical use, sanitation information, security precautions and policies, hotel services

- **Management and personnel**

Tasks and concepts: work scheduling, employee benefits, merit programs, disciplinary procedures, time management, corporate culture, goal setting, affirmative action training programs, safety rules and regulations, (OSHA standards), general accounting and auditing

- **Food service**

Tasks and concepts: food production, equipment use, recipe standardisation, menu development, food safety and sanitation procedures, mixology, wine selection and service, table service, personal hygiene, catering management, purchasing, storage and inventory management

- **Sales and marketing**

Tasks and concepts: sales calls, strategic marketing plans, special events, discounting, guest services

Source: Harris et al, (1993)

However, not only personnel training and development but also several other HRM applications are immigrating in the Internet. E-HRM is one area with huge benefits in automating processes and putting them on the Internet. For example, e-HRM applications could be: online employment applications, registration for health insurance and/or the pension programme, submission, approval and online lookup of expense reports and their payment status; publishing of new hires checklists, benefits on insurance benefits, lists of approved facilities and physicians, bonus information, performance review criteria, organisation charts, travel expense policies, approved vendors. Indeed, several hotel companies are using the Internet for recruitment purposes (e.g. advertising, submission of applications, applicants screening and identification etc), while some online solutions can streamline the whole recruitment process, reduce costs and time while increasing the potential recruitment market literally to include candidates from the whole globe.

Unfortunately, a recent study on the use of multimedia technologies in the UK tourism and hospitality sector (represented by B&B and the three star hotel sectors) (Sigala et al, 1999 and 2000a) revealed that the take up of multimedia for HRM purposes is extremely very limited.

7.4.3.20 E-business- Intranet-Email-Extranet
E-Business has been defined as the transformation of all business processes through the use of Internet technologies, i.e. Internet, Intranet and Extranet (Kalakota and Robinson, 1999), while according to IBM (www.ibm.com), e-business is defined as a secure, flexible and integrated approach to delivering differentiated business value by combining the systems and processes that run core business operations with the simplicity and reach made possible by Internet technologies. Overall, e-business means business without time and place boundaries.

The potential of e-business in the hospitality sector is great and promising. The need for hospitality firms to immigrate into an e-business model is being pushed by the digital economy. Members of the e-business committee of the American Hotel & Lodging Association (AH&LA) predicted that e-business would become an even higher priority for the hospitality industry in the near future in its effort to stabilise revenues and reduce costs in the very tough business environment created by the sudden and unexpected business downturn following the tragic events of September 11 2001. Alford (2000) also identified the following reasons for doing e-business in tourism and hospitality:

- build barriers against competitors and an effective strategic weapon;
- access a wider customer base and thereby increase market share;
- reduce distribution costs;
- streamline and rationalise process;
- improve efficiency and in so doing so, secure cost advantages;
- develop collaboration internally among colleagues and externally with customers, alliance partners and suppliers;
- manage the relationship with customers more effectively and thereby build customer loyalty.

The primary focus of e-business in hospitality is the digitisation of any aspect of a hotel, including business processes, its value chain, communications and information dissemination (IHRA, 2000). The important goal of hospitality firms is to "webify" their systems and applications so that they can be easily integrated with the Internet and company intranets, thereby opening up more business opportunities. This is because when all information is digitised, it can be easily and quickly accessed, shared and manipulated to drive faster and better decisions, streamline processes for efficiency and for minimising time to market. In other words, as Think Tank participants reported (IHRA, 2000, p. 3) *"digitisation allows hospitality firms the ability to codify and share information with anyone on a need-to-know basis following a just-in-time model* as well as *the formation of strategic alliances and partnerships, across industries and within industries – and sometimes with actual competitors".*

Therefore, in implementing e-business, with a growing eye towards virtuality, hospitality firms should maintain an enterprise-wide view of their company and look both inward and outward simultaneously for opportunities to apply ICT to transform business processes and generate efficiencies, new sources of revenues, or savings in the form of costs, materials, and/or labour. In doing so, hotels can streamline communications and processes and also move closer to the ideal of the "paperless office". In other words, with e-business, the primary aim is on reach, specifically extending the firm's resources and capabilities to allow it to do more with less.

For the tourism and hospitality industry in particular, the Tourism Enterprise and Management Consultancy Group (in Alford, 2000, p. 132) identified the following benefits for businesses immigrating to e-business practices: expanded market reach; end-customer relationship management and marketing; intermediary relationship management and marketing; more cost-effective distribution; enhanced quality of information; improved quality of service to customers; more effective supplier communication/transactions; more effective use of staff time; increased staff empowerment and satisfaction; teamwork culture; improved management information/accountability; more effective stock control; increased e-commerce income; efficiency cost savings.

Internet enabled technologies, i.e. Intra-, Extra and Inter- net are the major drivers of e-business. The main distinction amongst these systems is the access to members of an organisation and so, the network infrastructure (Table 7.4.3.20.a). It is evident that the distinction is based on access rights and not on geographical coverage.

Table 7.4.3.20.a Inter-, Intra-, Extra- net

Access Communication Infrastructure	Members of an institution	Closed user group	Open access
Open	Intranet	Extranet, Online services	Internet
Controlled/proprietary	Intranet	Extranet	On-line services

Source: Werthner and Klein (1999)

Intranet

A critical element of an Internet strategy is how a hotel presents itself to its employees, through the internal use of the Internet, known as the Intranet. Intranets are private computing networks, internal to an organisation, allowing access only to authorised users. They may include an internal "web" along similar lines to the WWW with multiple websites and webpages, electronic mail, newsgroups, online meeting facilities and any number of applications. Web browsers are used to navigate across information on the network and whilst authorised users can cross into the Internet, those outside the organisation cannot cross into the Intranet. As distribution of information is not restricted by time or geographical location and can be viewed by any employee within an organisation, the Intranet provides global communication within a corporate environment internally rather than externally (Goles and Hirschheim, 1997). Intranet collaboration tools make it possible for people to share ideas and collaborate on complex projects by allowing people to participate from geographically distant locations. Central copies of documents are available in team and chat rooms for easy access. Everybody can contribute to the same copy of a document, which reduces errors and the administrative time needed to copy and distribute documents, receive and incorporate changes, then redistribute. Collaboration tools also facilitate workflow or the movement of information from one user to the next, based on guidelines and rules. In brief, Goles and Hirschheim (1997) identified four uses of Intranet:

- Information publishing applications (what most organisations are currently implementing);
- Informal collaboration applications (e.g. web-enabled groupware, bulletin boards);
- Transaction-oriented applications;
- Formal collaboration applications (similar to lotus notes).

Choo (1998) clearly summarised the value added services and processes by which Intranets can add business value as follows: a) support information behaviour of users as they solve their work related problem situations; b) fit or improve organisation's information ecology, i.e. the environment that influences what information is produced, stored, is made available and is required by staff; c) the provision of a unified information space in which users can move seamlessly between content, engaging in communications and collaborating with others; d) facilitate the sharing and conversion use of the organisation's tacit, explicit and cultural knowledge; e) support organisation's knowledge creating and decision making processes. Clear advantages of Intranets are the reduction in duplication of information, reduction in paper/video/audio copying and distribution costs and faster, more direct access to information. Howard (1992) reported the following organisational benefits:

- Providing a raised awareness of and commitment to organisational objectives;
- Creating a "learning organisation" in which change becomes easier to cope with;
- Providing a greater degree of flexibility relating to both technology and people.

Benefits of Intranets for individuals include the following (Stayer, 1990):

- Making work more challenging, hence more satisfying; providing opportunities to work in ways to suit individual preferences with choice limited only by the need for co-operation and co-ordination;
- Increased social interaction through the organisation of work;
- Providing increased opportunities for self-development both on the shop floor and in the office, particularly through opportunities for learning and problem-solving.

In the context of the hotel industry, Long (2000) provided some examples of how Intranets can be used for communication, employee productivity and e-HRM practices. As corporate and department policies and information change frequently and everybody should be kept up to dated, the scope and flexibility of the Web are truly remarkable. For example, press releases, newsletters, administrative policy changes, company performance information, competitive, market and new product information, new property updates, renovation plans, financial, sales and performance statistics, near real time sales lead status reports and resource availability and marketing programmes in progress can be made available to anybody, anytime, anyplace. E-mail, Web collaboration and training/distance learning are considered to be the most critical Intranets applications that can boost employee productivity. Nowadays, a hotel chain may also reduce costs very quickly using the Internet as a communication link between the corporate offices and the properties and real savings come in reduced communication and administration costs from using the Web.

However, according to IHRA (2000) and Cline and Warner (1999) the most popular developments in e-business within the hospitality industry are Intranets and e-mail used as: a) portals that serve as gateways to important company information and systems; and b) communication vehicles for disseminating and sharing company news, standard operating procedures, forms, reports etc. to employees, management, franchisees, owners/investors and third parties, e.g. travel agents, suppliers. So although several companies have implemented Intranets, yet most have not realised their true potential in terms of cost savings, employee productivity and business effectiveness (Long, 2000). This is usually because information dissemination and communication very often creates information overload that is a classic example of a technology feedback loop, in which IT generates more information that may require even more IT to cope with it.

E-mail

E-mail connects people who may be geographically dispersed, allowing them to conduct business quickly and efficiently across time zones. It can also be a vehicle for distributing and maintaining the corporate culture through near instantaneous communication of information. E-mail is being used in order to facilitate both internal and external (e.g. with suppliers, customers) communication and co-operation. E-mails can also be saved in order to be used as official authentication as well as have broadcasting capabilities that facilitate rapid information dissemination. Finally, digital mails contribute to mobility, since they can be retrieved and answered from anywhere, e.g. through WAP enabled technologies. However, although the benefits of e-mail are apparent they are usually difficult to quantify:

- E-mail saves time for those who use it – through reduction of shadow functions, media transformations (like those of fax), interruptions, delays, unproductive overhead in face-to-face meetings (next time send a message) and the myriad of unproductive activities associated with paper-based communication systems.
- E-mail improves the quality of communications – through speeding up organisational communication, creating permanent searchable records of communications, reducing mistaken communications and forcing brevity, clarity and precision. E-mail for example has been found to strengthen relationships with customers, making it easier for them to communicate and to resolve problems.

Extranet

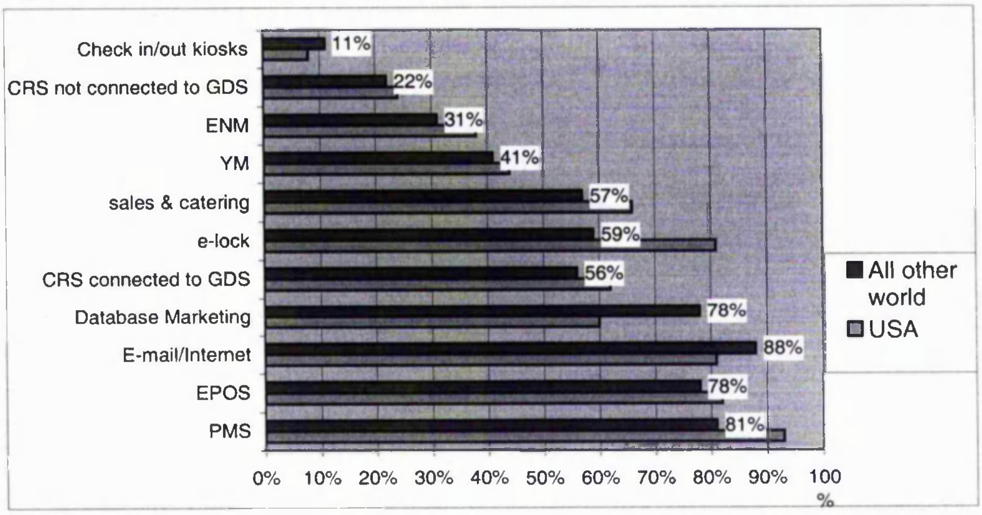
Extranets are being used in order to digitise business operations whereby third parties are involved (for example e-procurement, direct distribution and services to customers, joint projects). Thus, Extranet's benefits depends on the particular application that they are being used. Extranets are becoming popular because of developments in the ASP sector, which offers hotels the possibility to outsource and access business applications through web based technologies.

7.5 The adoption and diffusion of ICT in the hotel sector

Traditionally, the hotel industry has been reluctant to use IT. According to Wardell (1987) the lodging industry has been the most under-automated segment of international travel industry. Others (Archdale, 1993; McGuffie, 1990a, 1990b, and 1994; Beaver, 1992 and 1995; Go, 1992; Kasavana, 1982) attributed the low penetration of ICT in hotels to the difficulty that the industry faces in describing, standardising and managing rationally its product. Indeed, hotel managers have mistakenly viewed computerisation as the antithesis of personalisation and therefore, have considered it to be an unacceptable tool in the service delivery process. However, Levitt's (1972) arguments regarding the industrialisation of the service are of considerable merit particularly when considering the application of ICT in specific aspects of the guest life cycle such as reservations and the booking process. ICT can be used to strengthen the service encounter by improving delivery, consistency, reliability, accuracy of information, speed and efficiency of the transaction. ICT are a tool that when used appropriately, can augment staff skills by expanding their service repertoire (Barrington and Olsen, 1987), enhance personalisation (Treacy and Wiersema, 1995), provide an alternative form of service delivery (Berry, 1980) and merge the divergent worlds of the high tech and high touch (Sheldon, 2001).

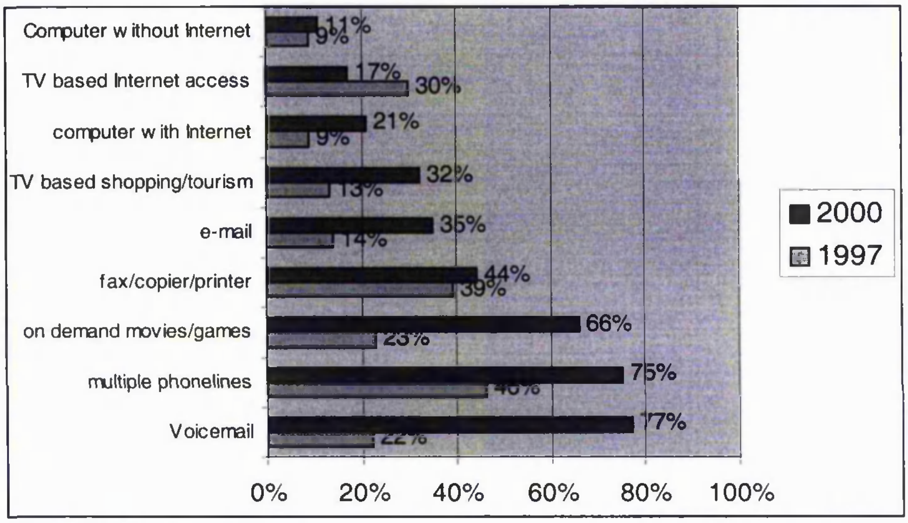
Nowadays, both hotel chains and independents' properties have adapted a whole system of ICT or are planning to introduce ICT (Whitaker, 1985; O'Connor, 1999; Peacock, 1995; Buhalis and Main, 1998; Go and Welch, 1991; Cline and Warner, 1999; Marsan, 2001; Sigala et al, 2000a). Figure 7.4.4.a and 7.4.4.b give the latest figures regarding ICT adoption levels in the global hotel industry. Some differences in adoption rates exist between hotel properties in USA and in the rest of the world, but generally ICT adoption patterns between the two regions are similar.

Figure 7.4.4.a Current availability of hotel ICT



Source: Marsan (2001)

Figure 7.4.4.b Current availability of guest room ICT



Source: Marsan (2001)

Research studies have revealed that factors like hotel size, market segment served, type of ownership and affiliation are the major factors affecting the ICT adoption rates amongst hotels. For example, Siguaw et al (2000) research on ICT adoption in USA also revealed that the following hotel variables significantly affected ICT adoption rates (i.e. number of technologies adopted) and patterns (i.e. types of technologies adopted): administration complexity (measured by the number of rooms); lodging segment (i.e. budget, economy, midprice, upscale, luxury); brand affiliation (independent versus chain affiliation hotels); and lodging type (all-suite, extended stay, convention hotel, casino, conference centre, condominiums, standard, motel, or B&B). Cline and Warner (1999) also reported that hotel size and affiliation significantly affected integration amongst ICT systems. In investigating the adoption (i.e. types and number of multimedia technologies used) and the diffusion (i.e. number of operations/activities performed by multimedia) of multimedia in the SMTHEs in UK, Sigala et al (1999 and 2000a) also reported that size (number of employees) and type of business (TIC, B&B, 3 star properties) had a significant effect on multimedia adoption levels and patterns of use. However, Whitaker (1985) highlighted that the number of ICT adopted was not found to be a good indicator of ICT diffusion, i.e. the sophistication and innovative use of ICT.

Studies revealing significant differences in ICT adoption and use among businesses within the same sector (i.e. the hotel sector) coupled with the fact that the productivity impact of ICT is very contextual dependent (i.e. how ICT are being used), most importantly highlight and confirm Keltner et al's (1999) position that an industry may not be the most appropriate level of analysis for conducting productivity studies. Thus, the selection of the level of analysis for investigating the ICT productivity paradox becomes crucially important. To that end, this study is limited to the three star hotel sector in order to eliminate the effect of contextual factors (e.g. type of market segment, competitive factors). However, the effect of several factors (i.e. size, fluctuations of demand etc) is also being investigated and/or controlled.

7.6 Conclusions

The study focused on the three star hotel sector in the UK that represents the mid price range hotel market and whose features and services are identified. An analysis into the structure, ownership and operating characteristics of the hotel sector in UK and of the three star hotel in particularly revealed that the latter represent a great majority of hotel operators in the UK hotel industry and are dominated by middle size hotels. Hotel chains and consortia have also considerably penetrated the three star hotel sector increasing its operating efficiencies and strategic competitiveness.

Due to the characteristics of the hospitality product and services, ICT applications also represent a crucial factor for enhancing hotel productivity and several models have been developed to illustrate the increasing diffusion and importance of ICT in all hotel operations. However, it was made evident that for fostering enhanced productivity benefits, hotel ICT applications should exploit the integration and information capabilities of ICT as identified in chapter five. Specifically, hotel reservation systems (either in-house or central) enable enhanced benefits and operational efficiencies when integrated with other external reservation systems and with other hotel internal ICT applications (e.g. guest history) as well as when they enable the collection and use of relevant customer and market information. In the same vein, front office, housekeeping ICT applications and check-in/out kiosks provide more benefits when they are integrated with other hotel applications (e.g. back office, hotel maintenance department) in order to facilitate and support staff communication and co-ordination, leverage of operational data, operational efficiencies. The issue of systems integration is more evident and crucial in ICT available in the sales and marketing department (distribution systems, customer databases, yield management systems) for the following reasons: the introduction of Internet enabled channels; the proliferation of distribution channels and the loss of room and rate inventory; the increasing guest requirements for personalised service; and the importance to identify and maintain customer relationships. ICT applications in the F&B division is also crucially important that they are integrated among each other as well as with other hotel division systems (e.g. PMS, customer database) in order to support the seamless flow of information and eliminate operational bottlenecks. How systems integration and information leverage can enable productivity benefits is also illustrated in the following ICT applications: back office systems; telephone systems; electronic lock systems; smart cards; videoconferencing systems; energy management systems; in-room ICT applications; e-procurement; executive information systems and decision support systems; HRM ICT applications. The problems regarding systems integration and compatibilities can be now addressed by the e-business revolution in the hotel industry. By webifying all hotel applications, e-business enabling technologies, i.e. Internet, Intranet, Extranet and e-mail, aim at creating a plug and play technological platform for enabling and supporting all hotel value chain activities.

However, although studies revealed that a great number of ICT are diffusing within the hotel industry, ICT adoption rates and patterns differ depending on the hotel size, ownership and management as well as the market segment served. Thus, as ICT use depends on these contextual factors, it is also expected that the ICT productivity impact would also differ between different types of hotels.

7.7 Summary

The structure, characteristics and operating features facing the UK hotel industry and in particularly three star hotels (i.e. this study's research sampled) have been identified and reported. Moreover, given the feature of the tourism and hospitality product, the importance and role of ICT for fostering and creating operational and strategic benefits have been highlighted.

In this vein, particular ICT applications in the hotel sector have been identified and analysed by illustrating how they can deliver enhanced organisational benefits by best exploiting the two ICT capabilities (identified in chapter five) namely systems integration and use of information. Systems integration is important for enabling BPR and systems synergies or else as Schmenner and Swink (1998) would argue for smoothening the flow of resources and eliminating bottleneck. In particularly, the different benefits and practices enabled when ICT applications are integrated with other ICT were illustrated, while the important and central role of PMS for creating an integrated hotel ICT infrastructure was stressed. Use of information gathered and analysed by ICT is also crucial for implementing CRM application and catering for personalised guests' requirements and needs.

Lastly, ICT adoption patterns and rates in the hotel industry revealed that ICT use depends on several contextual factors. This coupled with the fact that the ICT productivity impact is very contextual confirmed the argument that a reliable assessment of the productivity impact of ICT should be confined in a very specific sample in order to eliminate the impact of contextual factors. This study concentrates on the three star hotel sector.

CHAPTER EIGHT

Research objectives and methodologies

All scientific research begins with a topic and question of interest (Janesick, 1994). According to Kerlinger (1986), the research design represents and articulates the researcher's plan and the structure of investigation that will be followed when seeking answers to the research questions posed. Its role is *"to provide answers to the research questions and to control variance"* (Kerlinger, 1986, p. 280). Supporting this thinking, Yin (1994, p.18) defined the research design as *"the logic that links data to be collected and (the conclusions to be drawn) to the initial questions of the study"*. Simply stated, the research design serves as a blueprint that outlines the overall research programme and guides the investigator in collecting, analysing and interpreting observations (Kerlinger, 1986; Yin, 1994; Aaker et al, 1995). Hence, the purpose of this chapter is first to analyse the research objectives and then to present the research blueprint that not only guided the author to achieve her objectives but will also serve as a guideline to subsequent investigators wishing to replicate, reference or expand upon this study. This is an important chapter that often distinguishes a well-designed study from a poorly crafted one.

8.1 Research objectives

Despite the substantial investments in ICT in the hospitality sector (e.g. Marsan, 2001; Cline and Warner, 1999; Sigala et al, 1999), empirical studies have not persuasively established corresponding improvements in organisational productivity (e.g. Brynjolfsson, 1994). In fact, the relationship between ICT and productivity has been very elusive, leading to the development of the concept of the ICT productivity paradox. Given the vital and competitive importance of ICT in the hotel sector, the need to investigate whether and how ICT leads to productivity payoffs becomes crucially important.

Since previous research revealed that both productivity and the productivity impact of ICT are very situational dependent, research studies should try to eliminate or take into consideration the mediating effects of any contextual factors on the ICT-productivity relationship. As a preliminary research study (Sigala et al, 1999) reported increased adoption and diffusion rates of ICT within the three star UK hotel sector, it was decided that the framework of this study investigating the productivity impact of ICT should focus on this particular hotel sector, i.e. the three star hotel sector in UK.

This study has two purposes. First, the main purpose is to assess the impact of ICT on productivity in the three star hotel sector in the UK by proposing and implementing a robust methodology for unravelling the ICT productivity paradox. This purpose is implemented by dividing it into the following and more precise objectives:

- To measure hotel productivity by using a robust methodology;
- To distinguish between productive and unproductive hotels while also identifying the factors constructing their productivity frontiers, i.e. the factors that affect productivity;
- To investigate the ICT systems used by hotels as well as the ways in which ICT are being implemented;
- To identify whether hotels with different ICT availability (i.e. asset frontier) and/or ICT implementation (i.e. operating frontier) significantly differ in their productivity levels. Specifically, it is hypothesised that: hotels with more ICT assets and resources have significantly higher productivity levels; hotels with integrated systems have significantly higher productivity scores; and hotels that make more sophisticated use of their ICT systems and capabilities have significantly higher efficiency scores;
- To detect the specific productivity inputs and outputs on which ICT have an impact.

The second purpose of this study is to contribute and extend knowledge and literature on the fields of ICT and productivity. A substantial amount of work regarding productivity and ICT has been already conducted in other disciplinary areas. Instead of reinventing the wheel, this study aims to contribute to this body of knowledge and to make its findings and conclusions fruitful to researchers outside the hotel school community. In this vein, the study aims to fulfil the roles of "type four" research in tourism and hospitality (Wood, 1999) that is highly required as tourism and hospitality research has been increasingly criticised as to its limited contribution to the general body of knowledge. Arguments illustrating this latter point as well as the aims of a new direction in hospitality research are summarised as follows.

Several authors (e.g. Slattery, 1983; Taylor and Edgar, 1996) have argued that the hospitality industry has been traditionally regarded as a unique industry requiring unique methodologies to generate unique insights, which in turn led to a predominance of traditional, quantitative research studies at the expense of conceptual research. Taylor and Edgar (1996, p. 214 and 1999, p. 22) attributed this insular "uniqueness" approach to hospitality research and its corollary effect on the primacy of quantitative techniques to *"the links to vocational education and the perceived need for speedy and solid results"*, which in turn has also served to *"perpetuate the field's high degree of insularity and provided little or no tangible gains in respect of longer-term development"*.

However, Wood, (1999) argued that this largely "positivist" orientation in hospitality research highlights an important discontinuity with natural sciences. So, although positivistic approach to methodology in natural sciences is centred on hypothesis testing aiming at theory building and conceptual schema, according to Wood (1999, p. 17) *"in hospitality, we have the jelly without the cream"*, meaning that hospitality research is asserting methodological priorities over conceptual development. It is so not surprising that *"... hospitality research has little appeal to scholars more generally, as for the most part it consists of a body of individual studies that may or may not be utilised as a resource to illustrate broader and bigger themes and ideas but which, taken as an oeuvre qua oeuvre, consists of little more than a disconnected set of investigations with few if any linkages to a coherent body of theory"*, (Wood, 1999, p. 17).

Because of this gap in conceptual research, Wood (1999) argued that hospitality research has to proceed to a fourth approach. This type of research would: a) reflect hospitality researchers' approach to study hospitality phenomena outside the environment of hotel management schools; and b) be, in quantity and quality, substantial and agenda setting. Moreover, as hospitality research is attracting more and more attention from researchers outside the hotel school community, there is a high *"need for hospitality researchers to engage more actively with wider issues of theory and method in the broad areas of management and social science"*, Wood (1999, p. 17)

Arguments supporting the view that hospitality research should contribute to the general body of knowledge are also found in debates regarding the role of hospitality research. So, Litteljohn (1990, p. 211) identified four main aims of hospitality research:

1. to develop insights into areas of hospitality and the discipline of hospitality;
2. to underpin the content and direction of academic courses;
3. to encourage the development of best-practice techniques in industry;
4. to stimulate further research by dissemination and experimentation.

In a similar attempt to tackle the role of marketing management research, three research types of roles were identified (Hunt, 1991; Myers, Greyser and Marsey, 1979):

- basic research that aims to increase the general knowledge base of a field;
- problem-solving research focusing upon a particular company's problem in a given situation; and
- problem-oriented that lies in-between the previous two.

After reviewing the literature, Taylor and Edgar (1999) argued that basic research has been regarded as something that does not concern hospitality researchers, which also reflects the historical insularity evident in hospitality management education. Specifically, Slattery (1983, p. 11) argued that "*once the theory is selected and studied the scholar can then experiment with its application to hospitality management... applying social theories to the hospitality industry is ... about developing hospitality versions of the theories*".

Nevertheless, Taylor and Edgar (1999) questioned this general consensus that hospitality research should focus upon practical and relevant output that serves the needs of practitioners, i.e. problem-solving (e.g. Slattery, 1983; Litteljohn, 1990). Specifically, they (1999, p. 24) argued that "*if one accepts this view as representing the fundamental raison d' etre of hospitality research, how then does one resolve the potential situation where an important industry problem cannot be tackled with the current level of knowledge, as has risen uniquely within the hospitality industry and no other industry?*". Consequently, basic research should be recognised as "*an important area of activity for hospitality researchers*" while hospitality research should aim at the following threefold purposes (Taylor and Edgar, 1999, p. 24):

- uncover and make sense of existing patterns of behaviour and phenomena within the hospitality industry;
- identify new and better ways of managing within the hospitality industry;
- enable hospitality faculty to educate future practitioners through ensuring that they are equipped with the latest knowledge and thinking in relation to the task of managing hospitality provision.

Productivity has been extensively analysed by hospitality researchers. However, limited research has been done regarding the productivity impact of ICT in the hotel industry. On the other hand, the ICT-productivity relationship has been extensively studied in other sectors and fields. Moreover, productivity analysis being primarily an operations concept can substantially benefit from theories found outside the hospitality domain, i.e. the operations management literature. Thus, in order to proceed and fulfil the roles of a fourth type of research, the study had to draw, adapt and benefit from, as well as extend, theories outside the hospitality field.

In fact, hospitality knowledge has always drawn on multiple disciplines in management and other related behaviour and social sciences. As Shaw and Nightingale (1995) suggested, hospitality research is essentially the scholarship of integration (which reflects its interdisciplinary or multidisciplinary base) and the scholarship of application or what Taylor and Edgar (1996) called the scholarship of contextualisation. Maurreen et al (1999) have also recently argued that an interdisciplinary or multidisciplinary approach can lead to more realistic finding than a single discipline perspective (Figure 8.1.a).

Figure 8.1.a Summary of the differences between multidisciplinary and interdisciplinary research

Multidisciplinary research	Interdisciplinary research
Only the subject of the research is the same, e.g. time allocation of general managers	Examines a subject from different perspectives simultaneously
The philosophy of researchers is different	Research is more unified in its philosophy
Each discipline uses its own concepts and methods	A conceptually interlinked approach is developed
The approach to research may be different	Holistic, synergetic, understanding is achieved
Results can only be interpreted by each separate discipline	Results will be jointly analysed
Each discipline employs its own language	A meta-language is developed

Source: Maurreen et al (1999)

In particular, the study draws from knowledge developed in the field of operations management (i.e. the theory of performance frontiers) and its corollary methodology (i.e. DEA) as well as from knowledge in the field of ICT management and the ICT productivity paradox. The study examines the ICT productivity impact on the hotel sector from different perspectives simultaneously by developing a conceptually interlinked and unified approach as well as by using a meta-language in order to achieve a holistic and synergistic understanding of the phenomenon. In these terms an interdisciplinary rather than a multidisciplinary approach has been followed (Maureen et al, 1999).

Overall, the study aims to develop and test hypotheses by drawing on a coherent body of theory in order to fulfil the following objectives:

- To base and support the research study on a solid and already developed theoretical underpinning;
- To derive robust solutions and recommendations for the hotel industry based on strong and tested theoretical foundations;
- To identify best-practices materialising the productivity impact of ICT tools and capabilities, the main result of conducting a benchmark study;
- To enrich and contribute to hospitality research by bringing and adapting to the hotel sector theories and methods outside the hospitality field;
- To contribute and further enhance an already well-established field of research and body of knowledge by providing insight from a particular industry, i.e. the hotel sector. The study is thus claimed to be valuable for researchers outside the hospitality field;
- To identify areas and set a research agenda for further research.

8.2 Research design

8.2.1 Research methods

Effective research design must balance relevance with rigour (Benbasat and Zmud, 1999; Malhotra and Grover, 1998; DiMaggio, 1995; Weick, 1989 and 1995). To obtain valid and meaningful results from research, it is critical to employ and appropriately implement the most suitable method(s) for the topic of the study. The research methodology cannot be chosen arbitrarily. Instead, the research methodology is determined primarily by the research questions that drive the inquiry and second, by the current state of knowledge reported in the literature (Field and Morse, 1991; Morse, 1994; Janesick, 1994). These are further analysed as follows.

Yin (1994) also argued that the nature of the research question being asked predetermines the type of research methodology best suited to answering that question. Easterby-Smith, Thorpe and Lowe (1993) further developed the issue of what influences the research question by identifying key players in the study: the researcher (student, manager, academic, paid researcher); the stakeholders (academic community, commercial sponsors); and the subject of study (the topicality or volatility of the subject mater). In each case, the nature of the research question is influenced by both the expected outcome of the research (and the audience) and the kinds of data needed to answer the question. Depending on the type of the research questions, Yin (1994, p. 4) identified three distinct categories of research strategy:

1. *exploratory*; the study is a basis for formulating more precise research questions or testable hypotheses;
2. *descriptive;* the study simply observes and records issues or events over time;
3. *explanatory*; the study is used to trace operational links or causal relationships.

Thus, this study can be considered as an explanatory type of research since its primary purpose is to investigate the link between ICT and productivity.

Generally, one can select from two major categories of research methods namely quantitative and qualitative methods. In fact, there has been an implicit relationship between research philosophy, ideology and methodology in the literature, i.e. that positivism is related with quantitative research and survey methods while interpretative research is related with qualitative research methods. This is illustrated in a general agreement that the selection of particular techniques can be placed on a "quantity continuum" (Figure 8.2.1.a), where, by implication, qualitative techniques cease to be valid, reliable and generalisable the more subjects one requires to study. However, Wood (1999) questioned this implicit relationship. If qualitative research addresses qualitative issues by quantifying them as well as it can, then it can also be generalised, provided that the sample is carefully designed and selected. Thus in his terms, the issue in selecting the most appropriate method is not an issue of research philosophy but of achieving "fitness to purpose". To that end, the criteria for selecting methods must balance considerations of reliability, validity and generalisability against the nature of the research problem, its complexity and sensitivity.

Figure 8.2.1.a Methods of data collection showing a continuum of research methods and techniques relative to respondent group size and researcher's level of involvement

PRIMARY DATA COLLECTION	Social surveys questionnaires	Structured interviews	Unstructured interviews	Focus groups	Observations	Participant observation
SECONDARY DATA COLLECTION	Biographical analysis	Public records	Content analysis	Conversation analysis	Interaction analysis	Participant comprehension
RESEARCH METHODS Continuum						

PRIMARY DATA COLLECTION	**LOWER** ←	Level of personal involvement of the researcher	→ **HIGHER**
	LARGER ←	Respondent group size on research project	→ **SMALLER**
SECONDARY DATA COLLECTION	**MORE** ←	Level of subjectivity/interpretive flexibility	→ **LESS**

Source: Wood (1999) adopted from Worsley (1977)

However, there has been a great polemical debate regarding the scholarly nature (i.e. scientific rigour), the contributions and the differences between quantitative and qualitative research (Kerlinger, 1986; Lee, 1989; Yin, 1994; Christou, 1999; Denzin and Lincoln, 1994; Babbie, 1995).

The prevailing school of thought suggests that qualitative research is more appropriately applied in situations involving theory building, not theory testing (Sutton and Staw, 1995), though there are times when qualitative techniques are also appropriate for theory testing (Yin, 1994). With qualitative research, the aim is generally to explain or describe a pattern of relationships (Huberman and Miles, 1994). The data tend to be more subjective than for quantitative studies because the researcher attempts to establish themes, patterns and categories from the data based on his/her understanding and interpretations.

On the other hand, many traditional scientists argue that a quantitative approach to research is superior to a qualitative one because the use of statistics (inferential and descriptive), experimental design, and surveys are perceived to provide more scientific rigor and objectivity and therefore, support actual theory testing. The resulting products are said to have greater validity, generalisability and replicability and hence provide greater theoretical contributions. Additionally, a commonly held position is that scientific maturity of a field can only be achieved through empirical quantification (Lee, Barua and Whinston, 1997; Guba and Lincoln, 1994; Bakos and Treacy, 1986). Thus, to some a field is legitimised only after building a rich body of knowledge grounded in an abundance of quantitative empiricism.

The debate between qualitative and quantitative research is well-summarised by Denzin and Lincoln (1994, p. 4):

"The word qualitative implies an emphasis on processes and meanings that are not rigorously examined, or measured (if measured at all), in terms of quantity, amount, intensity or frequency. Qualitative research stresses the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry. Such researchers emphasise the value-laden nature of inquiry. They seek answers to questions that stress how social experience is created and given meaning. In contrast, quantitative studies emphasise the causal relationships between variables, not processes. Inquiry is purported to be within a value-free framework".

Mitchell and Bernauer (1998) also offered a more detailed explanation:

"Quantitative methodologies seek to understand causal relationships... by conceptualising, measuring and analysing information about the real world by means of numerical data representing explicitly defined variables. They analyse the data via statistical procedures to compare a large number of cross-sectional or longitudinal observations with the aim of identifying potentially strong, non-random, correlations between explanatory (or independent) variables and effects (or dependent variables).
Qualitative methodologists interested in evaluating and generalising causal inferences pursue the same goal. They also rely on explicitly defined variables but capture the values of these variables in words and analyse the data through other techniques... instead of isolating causal relationships through large numbers of cases

and statistical procedures, qualitative methodologists evaluate such relationships by holding other variables constant through careful case selection".

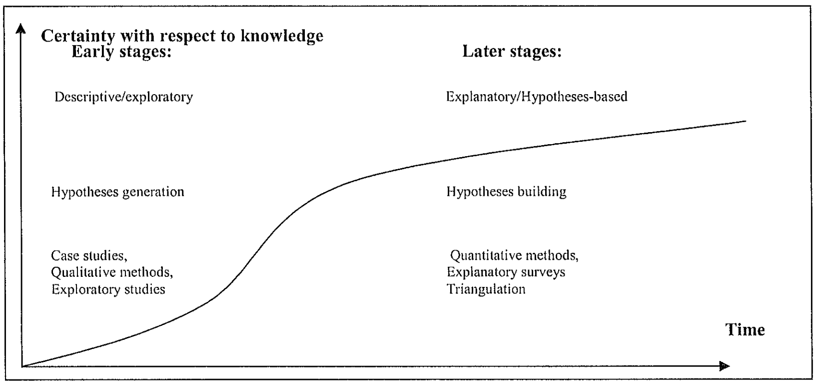
Nevertheless, there is also a growing realisation that both quantitative and qualitative research methods can coexist and complement each other throughout the research process. Mintzberg (1979, p. 587) summed up the synergetic relationship between quantitative and qualitative research in the following manner:

"for while systematic data create the foundation for our theories, it is the anecdotal data that enables us to do the building. Theory building seems to require rich description, the richness that comes from anecdote. We uncover all kinds of relationships in our hard data, but it is only through the use of this soft data that we are able to explain them".

Malhotra and Grover (1998) also graphically illustrated (Figure 8.2.1.b) how both qualitative and quantitative research methods can coexist and complement each other. In general, qualitative methods are better suited for descriptive and exploratory studies and help build an understanding and develop an initial theoretical foundation for a given phenomenon of interest. As the knowledge base pertaining to a particular phenomenon grows from exploratory and descriptive research, the research process will mature, enabling more empirical quantification and hypotheses testing that lead to the establishment of causal relationships and explanatory studies.

Thus, the process of knowledge should be viewed as a continuum or building process that takes place over time and involves multiple and different studies from different researchers. When quantitative and qualitative methods are used in conjunction in this manner, the overall theory developed will be stronger and more robust than it would otherwise be if only a single approach is used. As illustrated in Figure 8.2.1.b, each type of research plays both an important and necessary role in theory development, the common goal of all research (Dubin, 1978; Bagozzi, 1980; Kerlinger, 1986; Babbie, 1995; Sutton and Saw, 1995; and Malhotra and Grover, 1998).

Figure 8.2.1.b The research maturity cycle



Source: Malhotra and Grover (1998)

Overall, it should be highlighted that no type of research is more generally superior to another. The appropriateness and fit depend on the research questions, problem statement and context. The research method(s) chosen must be based on the research problem and context. In other words, the methodological choice follows the research question and problem context, not vice versa.

As concerns this study, despite the growing importance of ICT in the hospitality and tourism industry, the literature covering these topics is relatively limited. However, regarding this study's research question and context, ample research has been conducted in other disciplines on which hospitality research can be based as well as contribute to. Thus, there is an accumulated body of knowledge on which to build the conceptual framework as well as to construct a robust methodology for this study.

8.2.2 Research framework

After reviewing thirteen empirical studies of the performance impact of IT, Kauffman and Weill (1989) observed that a convergence is occurring particularly in the area of appropriate methods. In this vein, they concluded with an evaluative framework and a series of recommendations that identify strengths and weaknesses and aims to improve the quality of future research on the impact of ICT. The framework consists of three classes of considerations namely motivation for methods selected, focus of analysis and caveats for measurement. Each one provides a checklist of headings that need to be considered. So, motivation for methods selected refers to the purpose, methodological approach and theory base; focus of analysis takes into consideration issues of unit of analysis, locus or timing of IT value, and the role of information system performance; caveats for measurement emphasise the need to consider the reliability of specific performance measures, mode of data analysis and importance of organisational context.

In order to ensure the quality and value of this study, the development of its framework and methodology followed the Kauffman and Weill (1989) guidelines and considerations. These coupled with the issues that emerged from the literature review chapters as well as the methodological problems identified in previous research, helped in the development of the study's research framework that is analysed as follows.

8.2.2.1 Motivation for the methods chosen

All attempts to select the appropriate methodological approach are driven by and start from the purpose, research questions and theory base of the study. Moreover, Kauffman and Weill (1989, p. 387) argued that theories from operations management amongst others could offer "... *researchers rich means by which methodological progress can be achieved"*. The literature review illustrated that an emerging theory in operations management (i.e. the theory of performance frontiers) as well as its corollary methodology (i.e. production frontier techniques) provides a good theoretical framework that unifies pre-existing knowledge and gives a good framework for developing and testing hypotheses on how productivity differences and improvements can be achieved. Furthermore, research on the ICT productivity paradox has also revealed the benefits and advantages that DEA (a production function methodology) has regarding research on the ICT productivity paradox (see sections 4.3, 6.3.1.4. and 6.3.1.5).

8.2.2.2 Focus of analysis

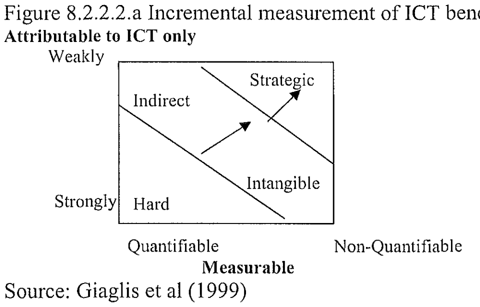
The focus of analysis includes what aspect of performance is of greatest interest to the researcher, what unit of the business is under investigation, locus or timing of the IT impact and whether the information systems are directly considered.

<u>Aspect of performance</u>

The study aims at assessing the impact of ICT on hotel productivity conceptualised to include efficiency, effectiveness and quality dimensions since ICT can impact on all these. In this respect, the operationalisation of the productivity construct included financial, aggregate and ultimate metrics of productivity outputs and inputs, which are claimed to incorporate the quality and effectiveness dimensions (e.g. Gummeson, 1998; Ball, 1993) and so overcome the methodological problem of previous research on the ICT productivity paradox concerning the metrics measuring productivity (e.g. Jurison, 1996; Hitt and Brynjolfsson, 1994; Quinn and Baily, 1994).

The caveat of using aggregate financial data is that one cannot distinguish the particular impact of ICT, e.g. increase in quality, efficiency or both. However, as Giaglis et al (1999) and Brown (1994) argued the investigation of the ICT productivity and performance benefits should be an incremental process starting from the identification of hard/quantifiable benefits and gradually moving to the analysis and quantification of soft and intangible benefits. In other words, the benefits measurement exercise should start with those benefits which are realized as a direct outcome of ICT and are readily quantifiable, namely hard benefits. Once these are studied, understood and measured, indirect and intangible benefits can gradually be brought into perspective and deliberated further. Strategic or competitive benefits can then follow as the ultimate step of this incremental approach. In other words, the ICT benefits at higher levels of complexity can be studied and measured more easily and accurately after a well understood model of the direct and quantifiable benefits is established and understood. Moreover, knowledge gained at each step of this incremental process enables both the incorporation of more indirect effects and the partial quantification of intangible benefits. Figure 8.2.2.2.a illustrates this argument. The arrows present the proposed route to ICT benefits measurement and assessment: climbing the ladder from quantifiable benefits attributable to ICT, to more indirect, intangible and/or strategic ones. In this vein, it was proposed that methodologies should evolve from quantitative to more qualitative approaches once a measurable ICT benefit is found in order to investigate further the nature of any soft benefits.

Figure 8.2.2.2.a Incremental measurement of ICT benefits



Source: Giaglis et al (1999)

Moreover, as previously analysed, methodological problems regarding research on the ICT productivity paradox also include issues regarding the quality of the data used (some studies used secondary sources) and the amplifier effect of ICT, i.e. the different effect of ICT in low and high performing companies. These issues are addressed by: a) collecting primary data from the industry specifically for the needs of this study; and b) investigating the relationship between productivity metrics and ICT only after high and low performers are identified through the use of DEA.

Unit of analysis

The unit of analysis of the study indicates the level at which the study is conducted, (e.g. industry, firm, process etc) and it directly affects any dilution effects, since as previously discussed the higher the level of aggregation, the greater the chances are of diluting the evidence that a link does exist between IT and productivity. Discussion on the methodological problems that the level of analysis can cause (e.g. Menon, 2000; Carlsson, 1993; Osterman, 1990) has indicated that the firm-level of analysis can be regarded as the best.

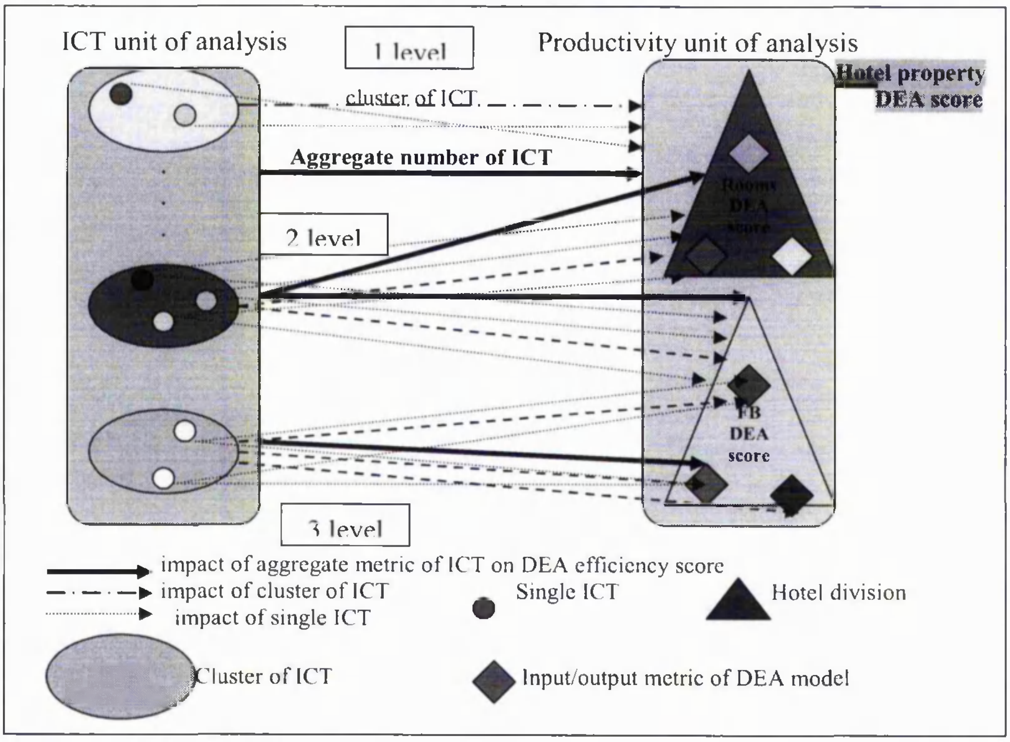
However, research at the firm unit level may suffer from potential dilution when a firm has several radically different business units. Research on productivity in the hotel sector revealed that productivity in the rooms and F&B division can vary considerably and is influenced by different factors. This issue is being addressed in this study by applying a stepwise approach to DEA in each division in order to identify the factors that construct the efficiency frontiers in each division separately and avoid diluting productivity measurement by applying DEA by using metrics referring to the whole hotel property.

Dos Santos and Peffers (1993) also highlighted that future research on the ICT productivity paradox should consider the fact that the relationship between productivity aggregate metrics and ICT can be diluted by the fact that intermediate metrics may not affect ultimate metrics. To address that, the stepwise approach to DEA is applied so that efficiency frontiers are constructed by breaking down aggregate metrics to their constituent parts only if the latter are found to have an effect on productivity scores. Thus, when interpreting research results, it should be noted that any relationship found between DEA scores and ICT metrics reflects an observed impact of ICT on the intermediate factors constructing the overall efficiency frontier.

Moreover, Dos Santos and Peffers's (1993) and others' (e.g. Willcocks et al, 1998) concerns regarding the level of analysis of ICT measurement, i.e. aggregate ICT metrics versus metrics reflecting functionality of specific ICT systems, are being addressed by considering the productivity effect of the availability of different ICT as well as the productivity synergy effect of different clusters of ICT.

Overall, the strength of the design of this study in terms of the level of analysis regarding both productivity and ICT measurement is summarised in Figure 8.2.2.2.b.

Figure 8.2.2.2.b The level of the unit of analysis of the study



As the figure illustrates, the study examines the productivity impact of single ICT, clusters of ICT as well as overall aggregate metrics of ICT. Regarding the level of productivity on which the ICT impact is being investigated, three levels are examined: 1) aggregate hotel DEA productivity scores; 2) hotel divisions (i.e. Room and F&B) DEA productivity scores; and 3) individual productivity input and output factors. The investigation of ICT impacts at these three levels of productivity analysis is attributed to the way that productivity has been measured. Specifically, a stepwise approach to DEA was used in order to construct robust DEA productivity models for each hotel division (thus DEA models in each division are built by inputs and outputs that significantly determine division productivity), while hotel overall productivity is measured by an aggregate DEA productivity score which is constructed by the individual factors influencing the productivity of the two hotel divisions. In other words, aggregate productivity metrics are developed by and include the individual factors affecting overall productivity. Thus, when an ICT impact on productivity is investigated on DEA aggregate scores, an ICT impact on the latter's constituent intermediate (functional) metrics also exists. In this way, the ICT impact on intermediate metrics that cannot be translated into ultimate results is avoided.

Locus or timing of IT value

Kauffman and Weill (1989) argued that the identification of the timing of IT value is crucial, because IT investments take time to add value to a firm and show up in performance measures. Methodologies following a longitudinal approach were argued to address such lag effects, however it is widely recognised (e.g. Strassmann, 1990; Menon, 2000) that because of factors such as the rapid changes in the competitive environment, the increased sophistication and requirements of customers and the great imitation among companies, businesses cannot afford to wait to accrue benefits from their ICT investments. Instead companies should know how to manage, implement and continually enhance their ICT exploitation in order to ensure materialisation of any ICT benefits.

Moreover, Kauffman and Weill (1989) argued that cross-sectional data can also be used in order to test similar hypotheses on IT effects with longitudinal studies. To this end, time-series are simulated with data sets that derive from companies that have or have not invested in specific IT and test whether a specific impact occurs in both cases. Such an approach is very important when longitudinal data are difficult to collect or when there are time and cost limitations to the study. In this vein, it can be argued that this study is a simulation of a longitudinal study, since it investigates productivity differences between hotels that have different ICT configurations. The value of longitudinal studies for investigating the ICT productivity paradox was argued to be that they overcome the time delay for ICT benefits to materialise. Hence, the identification and productivity comparison between hotels with different ICT is also argued to overcome in some way time delay problems related with the ICT productivity paradox.

The role of information systems performance

Under this consideration, it is being argued that performance issues regarding ICT projects should be taken into consideration. In this vein, factors such as information systems effectiveness and management should be considered. However, as previously discussed, ICT effectiveness in isolation is not a good practice to assess the ICT productivity impact but it is rather better, in methodological terms, to treat it as a mediating rather than a criterion variable (e.g. Kauffman and Weill, 1989). On the other hand, methodological issues regarding the management and implementation of ICT are considered as crucially important when investigating the ICT productivity paradox. To that end, the study methodologically addresses the issue of ICT mismanagement by identifying and measuring three crucial ICT factors, namely availability of different types of ICT systems, their integration and their sophistication of use.

8.2.2.3 Measurement caveats

Reliability of specific performance and ICT measures

Banker et al (1989) suggested that performance measures must represent the probabilistic nature of IT impacts. In this vein, a stepwise DEA approach was used in order to investigate the productivity effect of a wide spectrum of factors that ICT could affect. Banker and Kauffman (1988) also added that measures and models to identify the ICT productivity linkage should be related to the theory bases used. To that end, a wide spectrum of theories explaining how ICT can impact on productivity were reviewed and summarised into a comprehensive and integrated model (sections 5.3 and 5.4). This analysis in turn provided the dimensions of ICT tools and capabilities namely systems integration and sophistication of use (i.e. automating, informating and transformating activities) that are argued to affect the type and amount of productivity benefits and so they need to be measured and then related to productivity metrics (section 5.5).

Mode of data analysis

The mode of data analysis refers to the statistical method used to analyse the collected data. This study uses the DEA methodology, which overcomes the productivity measurement problems that other techniques have while also having unique features that enhance analysis (i.e. the consideration of external factors, the use of different measurement etc). These are analysed in more detailed in sections 4.3, 6.3.1.4. and 6.3.1.5. However, in brief, benefits from using the DEA for investigating the ICT productivity paradox are as follows: DEA generates an overall measure of efficiency for each company evaluated; DEA provides the flexibility simultaneously to include multiple inputs and outputs that are relevant to a specific research project and irrespective of their units of measurement; DEA results provide good information on where improvements are required; DEA results can be further analyzed using traditional statistical techniques such as hypothesis testing and regression analysis; DEA can be used in order to identify and characterize a population of companies which can be further analyzed via in-depth case studies.

Importance of organisation context

Bakos (1987) asserted that answering questions about the value of IT places a premium on identifying methodologies that allow us to control or compensate for contextual variables when it is feasible. Contextual factors can be any characteristic of an organisation that theory indicates may impact on productivity and/or the use of ICT, which in turn can have an effect in the investigation and identification of any relationship between productivity and ICT.

In previous analysis (section 2.3) it was shown that theory and research indicate that hotel size, market segment served, business variability, hotel ownership and management arrangement, type of distribution channels used and employment patterns regarding the use of part and full time staff may affect productivity, while type of ownership and management arrangement as well as hotel size may affect ICT use (section 7.4.4). To address contextual factors, the study used DEA in a stepwise approach, i.e. incorporating in the DEA productivity model only the factors that are found to affect efficiency scores as well as applying hypothesis testing tools in order to investigate significant differences among different types of organisations. Wider contextual factors that may affect the identification of a relationship between ICT and productivity such as the type and nature of business operations, competitive forces etc are addressed by focusing on a highly defined sector, i.e. in the three star hotel sector.

Overall, it is being argued that the research framework used in this study addresses most of the methodological problems identified in previous research. This claim is summarised in Table 8.2.2.a.

Table 8.2.2.a The research framework and its advantages for investigating the ICT productivity paradox

Research framework dimension	Approach of study	Methodological issue addressed
Motivation for methods chosen	The research methodology was driven by the purpose, research questions (i.e. assess the ICT productivity impact) and theory base of the research (i.e. performance frontiers)	Lack of a unified theoretical basis explaining productivity improvement and differences
Focus of analysis		
Aspect of performance	Focus on productivity conceptualized as incorporating quality, efficiency and effectiveness and operationalised in financial, aggregate and ultimate data	• methodological issues regarding the consideration of ICT impacts that were argued to be ignored, e.g. quality improvement • assess whether ICT benefits are materialized in ultimate metrics
Unit of analysis	• Productivity measurement at the company-level, but which: o addresses the different productivity issues in two distinct hotel divisions, i.e. rooms and F&B o constructs efficiency frontiers by breaking down aggregate metrics into their constituent / intermediate parts • ICT measurement that considers the productivity impact of: o Different, individual ICT o clusters of ICT (synergy effects)	• Overcome dilution effects of macro-studies at the economy or industry level; • Overcome dilution effects created by aggregate data measured at the firm level, when firms consists of distinct divisions; • Overcome problems of generalization and data collection concerning process-level studies • Overcome problems regarding the use of aggregate ICT financial metrics • Address problem regarding relating ICT with intermediate metrics that affect ultimate results
Locus of timing	Cross-sectional study	Use data sets of hotels with different ICT metrics to simulate time-series, longitudinal research Address time and cost limitations when longitudinal studies cannot be used
Role of IS performance	Use of three ICT metrics that reflect the effective exploitation of ICT tools and capabilities to enhance productivity	Address methodological problems regarding ICT mismanagement and mismeasurement
Measurement caveats		
Reliability of performance and ICT measurement	Use of a wide range of factors that ICT could affect and use of DEA to simultaneously consider multiple input and output factors Review literature and summarise it into a model that identifies the ICT issues that affect productivity benefits	Overcome problems regarding the reliability of research metrics
Mode of data analysis	Use of stepwise of DEA	Overcome problems of data analysis Benefits from DEA features
Contextual factors	Consideration of factors affecting: • Productivity through the use of DEA and hypothesis testing methods • ICT use through hypothesis testing methods	Overcome problems regarding the quality of data used and analysed Investigation and achievement of more reliable results

8.2.3 Research method selected

Based on the information needs of the study (i.e. the collection of hard financial and other quantifiable data as well as data regarding ICT implementation from a large and geographically dispersed population) the survey methodology was used. Lucas (in Brotherton, 2000) argued that survey research is about looking and searching in order to answer a question, or a series of questions, which can be closely focused or broadly drawn and may seek to test a hypothesis or a set of hypotheses. In this vein, survey research can address a wide range of topics both external and internal to a firm (Alreck and Settle, 1985; Moser and Kalton, 1986; de Vaus, 1996). The survey methodology was chosen because of the following advantages: a relatively small sample can efficiently and effectively elicit data about a larger population; it is versatile when different modes of enquiry are used, e.g. telephone, postal and email survey; it can be comprehensive and flexible in regard to simple or complex data requirements; surveys can be customised to accommodate time and costs limitations.

Tull and Hawkins (1993) classified survey methods according to the method of communication used in the interviews as: personal, telephone, mail, computer (e-mail). Table 8.2.3.a evaluates the strengths and weaknesses of these methods in terms of eight criteria.

Table 8.2.3.a Appraising the Survey Method

Criterion	Mail	Telephone	Personal	Computer
1. Ability to handle complex questionnaires	P	G	E	F
2. Ability to collect large amounts of data	F	G	E	G
3. Accuracy on "sensitive" questions	G	G	F	G
4. Control of interview effects	E	F	P	E
5. Degree of sample control	F	E	F	F
6. Time required	P	E	G	G
7. Probable response rate	F	F	F	F
8. Cost	G	G	F	F

Codes: E=Excellent, G=Good, F=Fair, P=Poor

Source: Tull, D. and Hawkins, D. (1993)

Lucas (in Brotherton 2000) provided a more detailed summary of the advantages and disadvantages of the different survey methods (Table 8.2.3.b).

Table 8.2.3.b Comparison of survey methods

Advantages		
Postal survey	***Face-to-face interview***	***Telephone interview***
Can be cheap	Flexible	Cheap
Results can be generalised	Insightful	Quick
Structured process	Qualitative results	Large samples
Large samples	Interaction with respondent	Reach widely dispersed sample
Large amounts of data	Probing	Can elicit sensitive data
Data easily classifiable	Low non-response bias	Interaction with respondent
Quantifiable results	Visual stimuli	Low non-response bias
Disadvantages		
Postal survey	***Face-to-face interview***	***Telephone interview***
Detailed administration	Time consuming	Few data per respondent
Potential for low response	Small samples	Partial picture
Partial picture	Interviewer training required	Some interviewer bias
May only be indicative	Interviewer bias	Some interviewer training
No interaction with respondents	Data recording and classification problematic	
	Logical considerations	

Source: Lucas (in Brotherton, 2000)

In this vein, the mail survey method was chosen in order to gather a large amount of complex and detailed data from a geographically dispersed and random sample in a time and cost effective way. However, the mail survey of this study suffered from low response rates even after a follow up was conducted (more information is given in the section titled sample design and selection provided below). As part of the strategy to overcome this problem, the researcher distributed the questionnaire through e-mail to a highly identified audience. Distribution of the questionnaire through email benefited the research in terms of time (quick dissemination of the questionnaire and receipt of responses) and cost (a minimal cost for email communication) as well as it helped to identify easily and quickly those that responded and so carry out a follow up.

8.2.4 Establishing validity and reliability

In developing constructs, the issues of validity and reliability become important (Fink, 1995). The overarching concept of validity is to ensure that a study reflects the true meaning of the concepts under investigation. Validity is "*synonymous with truth, strength and value*" (Brinberg and McGrath, 1985, p. 13). There should be a high degree of congruence between what is being measured and the instruments and variables used to measure them to ensure that the essence of reality is accurately captured, interpreted and reported.

Simply defined, construct validity refers to the extent to which an operational-level variable being measured represents a conceptual-level variable of interest. In fact, construct validity is an umbrella term that comprises many different kinds of validity, including (Bringberg and McGrath, 1985; Kerlinger, 1986; Yin, 1994; Babbie, 1995; Fink, 1995; de Vaus, 1996):

- convergent and discriminant validity; i.e. how similar a construct or measure is to itself but how it differs from others;
- content validity; i.e. how well a construct or measure covers the range of meanings included in the concept;
- face validity; i.e. how reasonable or believable a construct or measure is when taken at face value.

Establishing construct validity is often a great challenge. Alreck and Settle (1985) argued that validity represents the adequacy with which a specific domain of contents has been sampled and it is determined based on two criteria: determine whether an instrument contains a representative collection of items; and determine whether a satisfactory method to test the instrument is used. Additionally, Yin (1994) suggested three commonly used tactics for increasing construct validity: multiple sources of evidence to demonstrate convergent lines of inquiry (triangulation); the establishment of a chain of evidence to link questions asked, data collected and any conclusions drawn; and the review of preliminary findings by key participants or informants. As noted by Yin (1994) and Oppermann (2000) triangulation is a common means to satisfy the conditions of construct validity. Denzin (1978) and Patton (1987) introduced four types of triangulation, which were later expanded by Janesick (1994) to include a fifth kind. These include:

- *data triangulation*; the use of multiple sources of evidence in a study;
- *investigator triangulation*; the use of multiple researchers and/or evaluators;
- *theory triangulation*; the use of multiple perspectives or rival theories to explain and interpret a set of data;
- *methodological triangulation*; the use of multiple methods in a study to investigate the same problem;
- *interdisciplinary triangulation*; the use of multiple disciplines to inform a research process.

In order to meet these criteria and ensure construct validity, the variables and measures used for this study were developed as follows. An extensive review of the literature was conducted in order to draw upon the previous research and knowledge to support each of the constructs identified and their operationalisation. As a result, an elaborated list of items was generated which in consultation with the researcher's supervisory team was refined and redundancies and inconsistencies were eliminated.

Moreover, based on the literature review, the development of a data analysis technique called stepwise DEA analysis for manipulating multiple input and output data and exploring their relationships as well as the construction of a model for analysing ICT systems and for identifying ICT elements that can predict higher productivity were also important steps in establishing construct validity.

For meeting the second criterion suggested by Alreck and Settle (1985), the researcher had the opportunity to test the questionnaire while participating in an IT Think Tank that gathered both ICT and hotel professionals involved in the international hotel industry (IT Think Tank organized by the IH&RA in February, 2000). Overall, seven people gave their feedback (4 professionals working in the hotel industry and 3 professionals working in the hotel ICT supply industry). The questionnaire was also piloted with six hotel general managers, i.e. the target market of the questionnaire. Moreover, according to Yin's (1994) fourth suggestion preliminary findings were analysed and discussed with the researcher's supervisory team in order to ensure the viability and soundness of the methodology.

The validity of the study was also ensured by employing three aspects of triangulation: investigator triangulation was established in the questionnaire testing process by selecting people from different fields, i.e. professionals working in the hotel ICT supply industry and hotel managers/directors; theory triangulation; and interdisciplinary triangulation were achieved by using a theory in operations management (i.e. the theory of performance frontiers) that unifies previous theories from different disciplines (i.e. economics, operations management etc). Interdisciplinary triangulation was also achieved during the literature review stage by drawing upon the works of many different disciplines including strategy, hospitality, marketing, operations management, productivity, organizational economics, Information Management, Information Systems, Information and Communication Technology management.

Internal validity applies only to causal or explanatory research (Fink, 1995). Its role is to ensure that any threats to validity have been identified so as to protect any interpretations or explanations from spurious effects, including confounding or latent variables (Kerlinger, 1986; Yin, 1994; Fink, 1995). In other words, internal validity addresses the measures used in the study and their ability to measure or predict what they are intended to measure or predict and that there are no outside forces or hidden variables influencing the findings.

The following steps were taken in order to ensure internal validity of this study: conduct a comprehensive and thorough review of an interdisciplinary literature; use a stepwise DEA methodology in order simultaneously to take into account the productivity impact of multiple inputs and outputs and so eliminate confounding effects; and focus the research study on the three star hotel sector in order to eliminate contextual factors that may influence findings of any relationship between ICT and productivity.

Reliability addresses issues of confirmability and dependability (Tull and Hawkins, 1993). The objective of reliability tests is to ensure that subsequent researchers, using the same cases and following the procedures described in this chapter will realise the same findings and conclusions as this study. Essentially, tests for reliability ensure replication by others by addressing dependability of the study and its findings (Kerlinger, 1986; Yin, 1994; Fink, 1995). Reliability attempts to remove all (or at least to the extent possible) error, biases and subjectivity.

To achieve reliability, questions were carefully worded and developed in order to avoid probing answers and to eliminate respondents' bias. Moreover, many of the questions were structured, while those questions that were open required respondents to provide hard and financial data of their property. However, apart from developing a structured questionnaire and requiring objective data, reliability requires respondents to interpret, understand and answer questions according to the study's needs. To that end, the piloting of the questionnaire provided useful insight into the reliability and usefulness of the instrument.

8.2.5 Development of constructs

First, in order to ensure comparability of data amongst hotel properties, respondents were asked to provide data regarding the financial year ending in 1999. According to the literature review (section 2.3), data on the following contextual factors that could have an impact on productivity were collected: hotel location, hotel design, ownership structure, management arrangement, business variability over the year, business variability over the week, proportion of repeat customers, average length of stay, market segments served, distribution channels used, the use of part time staff and hotel size. Specifically:

- location was identified as rural, city centre or suburban;
- hotel design was operationalised as old and/or traditional, redesigned/converted or purpose built;
- ownership structure corresponded to independently owned or chained owned hotel;
- management arrangement was operationalised as independent management, chain management, independent management and consortia membership or franchise;
- business variability was calculated by asking respondents to characterize fluctuations in business both over the year as well as over the week as greatly, somewhat or not at all. Responses were scored (1=greatly, 2= somewhat and not at all=3) and an overall score of business variability was calculated for each respondent by multiplying the score of business variability per year with the score of business variability per week. As concerns business variability scoring, the higher number was chosen to correspond to less business variability because of the following reason. Theoretically, the lower the variability the higher the productivity. Business variability is treated as an uncontrollable input of the DEA model. However, because in DEA productivity models, higher values of inputs should relate to higher values of outputs, that meant that higher values of business variability (i.e. lower business fluctuations) should lead to higher outputs;
- a percentage of repeat guests was also collected;
- respondents were also asked to provide the number of days corresponding to the average length of stay in their properties;
- market segments served were identified based on break down figures regarding percentages of total roomnights referring to business travellers, leisure travellers, conference travellers, conference and/or other;

- distribution channels used were identified based on break down figures regarding percentages of total roomnights received through a property owned system (e.g. telephone, fax etc), third parties and/or Internet (www, e-mail etc);
- data on the use of part time staff were collected by asking respondents to give the percentage of total payroll expenses referring to full time staff as well as the number of full time and part time staff employed in their property (the number of full time equivalent employees was not used as it was decided and found that many of the target population do not have this figure);
- hotel size considered hotel capacity in both rooms and F&B division; specifically respondents were asked to provide data regarding the number of rooms and bedspaces/sleepers as well as data on the maximum banquet capacity and restaurant seats of hotels.

All these variables were considered as inputs into the DEA productivity models. In addition, the following variables were also considered as hotel productivity inputs: number of full time employees in front office, housekeeping, F&B, telephone/switchboard, administrative & general, minor operations, marketing, maintenance and other; the number of heads and/or managers of departments; the number of information technology technicians; annual expenditure regarding direct material expenses, payroll and related expenses and/or other expenses broken down in the following hotel divisions/categories front office, housekeeping, F&B, telephone/switchboard, minor operations, administrative & general, marketing, maintenance and training on ICT; annual energy expenses; annual management fees (if applicable).

As regards DEA productivity outputs, data regarding the following variables were gathered and used: average annual room occupancy; average room rate (ARR); roomnights achieved; restaurant covers; banquet covers; annual hotel profit before fixed charges; annual hotel revenue; percentage of hotel revenue corresponding to the following departments: rooms division; F&B; minor operations; and telephone/switchboard.

According to the literature review, three core ICT elements were found to affect productivity namely functionality of ICT systems, systems integration and sophistication of use reflecting the degree of exploitation of the network and information capabilities of ICT. In this vein, the construct measuring ICT investment was operationalised by using three metrics: availability of different ICT systems, measured as the total number of ICT or the number of available ICT in particular ICT clusters; the integration of available ICT with the PMS (the digital nervous system of the hotel ICT infrastructure) as well as ICT system integration with other systems; and sophistication of use of ICT.

To that end, the study identified 34 core ICT systems that can be available in hotel properties namely: global distribution systems (GDS), YM systems, property based reservation system, check in/out kiosks, human resource management system, finance and accounting systems, conference and banqueting systems, food and beverage systems, stock and inventory systems, electronic point of sale systems, automated mini-bars, in room office facilities, TV based services, voice mail, on demand movies/games, in room Internet/e-mail access, e-procurement systems, e-lock systems, energy management systems, telephone systems, videoconferencing systems, management or executive systems, decision support systems, customer database, smart cards, marketing and sales systems, front office systems, central reservation system, property management system (PMS), hotel website, e-mail, Intranet and Extranet. Respondents were asked to report whether they had any of these ICT systems as well as to indicate with which systems each available ICT is interfaced. PMS integration of ICT as well as direct integrations amongst ICT systems were measured and their impact on productivity investigated.

However, in order to keep the questionnaire short and easy to fill in, it was decided that the sophistication of use of only major and crucial ICT systems would be measured. The literature review and discussions with experts at the IT Think Tanks revealed the following ICT as vital and critical for the hotel industry nowadays. First, PMS availability, because of the PMS's central role and its power to enable other applications and to develop the hotel digital infrastructure. The availability of Internet technologies and specifically the availability of a hotel website, e-mail, Intranet and Extranet. These ICT are nowadays vitally important because of the trends in e-commerce and e-business, i.e. the webification of hotel operations. And last, the availability of a customer database or warehouse because of the increasing role that customer databases play in integrating and enabling other operations (e.g. distribution, front and back office operations) as well as because of its ability to develop a customer centric hotel and ICT infrastructure.

The sophistication of use was operationalised by developing a set of ICT uses based on the framework developed in section 5.6, which in fact reflects the degree to which hotels are exploiting the core ICT elements i.e. integration/network capabilities and informalisation capabilities. Respondents were asked to report whether they used each ICT system for the uses provided. However, as previously argued, higher degrees of exploitation are hypothesised to lead to higher productivity levels and so, types of uses were weighted (1, 3 or 5) in order to illustrate the different productivity impact that they may have. In this vein, an overall sophistication score for each core ICT was calculated not by accumulating the number of its uses but rather by summing up the weighted scores that corresponded to each type of ICT use that the respondent reported. The weights of one, two and three were used as in Brady et al's (1999) study whereby they also used the same approach to measuring ICT marketing applications for investigating the impact of ICT on marketing; their hypothesis was similar to this study's, i.e. the ICT impact was expected to be greater in firms which have reached a transformative mode of ICT use. Ultimately, the ICT sophistication score was used in inferential statistics (i.e. Pearson correlations and t-tests) in order to test the hypothesis that higher ICT sophistication leads to higher productivity levels.

Specifically, six types of uses were developed in order to summarise the degree of exploitation of PMS capabilities and so, the sophistication of PMS use was measured as follows (Table 8.2.5.a). Automation of front office operations and automation of back office operations. These two types of PMS use were weighted with the score of one as they only reflect a localized exploitation of PMS's capabilities for automating isolated hotel operations and so productivity impacts are expected to be low. The use of PMS for collecting and storing data as well as for communicating and sharing it between hotel departments were weighted with three because they demonstrated a higher degree of exploitation of the network and informalisation capabilities. However, when information gathered was analysed and used to produce reports for enhanced decision making as well as when the PMS was used in order to create an electronic ICT infrastructure to enable other applications even higher productivity benefits can be expected and so, these uses were weighted a score of five.

Table 8.2.5.a Measurement of PMS sophistication of use

Type of use	Weight
Automate front office operations	1
Automate back office operations	1
Collect and store data	3
Communicate and share information between departments	3
Analyse data and/or produce reports	5
Create a platform that supports other applications	5

Hotel website sophistication was measured by the following types of uses (Table 8.2.5.b). The use of an hotel website for information provision and links to other sites reflected only a very limited exploitation of the Internet's capabilities namely interactivity, connectivity and convergence, which was not expected to lead to enhanced benefits and so these uses were weighted with a score of one. The provision of online bookings (and so systems integration, e.g. between hotel reservation system, web booking facility and/or customer database) and the use of the Internet to communicate with customers demonstrate a more sophisticated use of the Internet's capabilities and so was weighted with the score of three. A score of five was given when hotels collected customer information as well as provided customized content, as they illustrated higher levels of exploitation of the informalisation, interactivity and network capabilities.

Table 8.2.5.b Measurement of Website sophistication

Type of use	Weight
Provide information, e.g. on the hotel property, job vacancies, special offers	1
Provide links to other sites	1
Provide real time, on line bookings	3
Communicate with customers	3
Collect customer information	5
Provide customised content, e.g. customised deals, access to loyalty program	5

Table 8.2.5.c illustrates the measurement of sophistication of e-mail, Intranet and Extranet. In the same vein, the use of ICT for automating front office and back office operations as well as for storing information was weighted with the score of one, ICT uses for automating transactions either with suppliers or with customers was weighted with three since it illustrated a higher level of systems integration (integration between hotel ICT and third parties systems), while the use of systems for enabling internal and external communication was weighted with five, since the network and informalisation capabilities were exploited for supporting more operations and activities than transactions.

Table 8.2.5.c Measurement of e-mail, Intranet and Extranet sophistication

Type of use	Weight	E-Mail	Intranet	Extranet
Automate front office operations	1			
Automate back office operations	1			
Store information, e.g. hotel policies, application forms	1			
Make room reservations and bookings	3			
Conduct transactions with suppliers	3			
Enable internal communication and/or co-operation	5			
Enable external communication, e.g. with suppliers	5			

Black boxes refers to activities that e-mail cannot be applied

Customer database/warehouse sophistication was measured by developing the following six types of uses (Table 8.2.5.d). Use of customer database for automating isolated operations in sales and marketing, front office and/ore back office was weighted with the score of one. When the database was used in order to enable staff from different departments to access and use the customer information as well as to personalize marketing efforts a score of three was given, since the networking, integration and informalisation capabilities of the customer database were exploited. However, a score of five was given when hotels reported use of the database for delivering CRM activities (i.e. enhanced exploitation of information and systems integration) as well as to plan the hotel strategy, such as developing customer centric operations and organizational culture.

Table 8.2.5.d Measurement of customer database/warehouse sophistication

Type of use	Weight
Automate tasks of sales and marketing staff	1
Automate tasks of front and/or back office staff	1
Enable staff of different departments to access/use customer information	3
Plan personal customised promotions and/or sales offers	3
Deliver Customer Relationship Management activities	5
Plan the hotel strategy	5

8.2.6 Questionnaire design and administration

In order to ensure high response rates and the collection of valid information, the questionnaire design followed the following process. Questions were developed in order to be sufficiently focused to obtain the required answer, succinct to minimise error and bias, and uncomplicated to aid common understanding (Alreck and Settle, 1985; Oppenheim, 1992; Fink, 1995; Christou, 1999). Required data focused on information that respondents usually gathered and that they could easily obtain from hotel databases.

The questionnaire was piloted with six local hoteliers in order to avoid use of ambiguous terms as well as to test the feasibility and usefulness of the instrument. The format, wording and variables of the questions were pre-tested in order to ensure a mutual understanding between the researcher and the respondent and that all the necessary data could be collected. As a result some fine-tuning was conducted in order to enhance the quality and accuracy of the instrument, e.g. the term independent and consortia management was replaced with independent management and consortia membership, to the wording of the question requiring the annual hotel profit had to become more precise highlighting that the annual profit before charges was required in order to avoid respondents' confusion as well as to eliminate the bias of this figure from the different circumstances that hotels might face.

In order to ensure that the questionnaire was easy to complete and to avoid putting off respondents from completing it the following steps were undertaken. Four sections of questions were developed within which questions flowed logically and meaningfully. The length of the questionnaire was limited to four A4 pages (one page for each section of questions) that were presented in one double printed and folded A3 page.

The first section included easy to answer questions, in order to avoid losing respondents' interest and commitment to fill in the questionnaire, that aimed at collecting information regarding the contextual situation of the hotel (e.g. hotel size, hotel ownership, location etc). The second section aimed at gathering information regarding hotel productivity statistics. This section required a high level of involvement, time and effort from respondents since it requested highly sensitive and much more detailed information. To ensure respondents' attention and effort, special care was taken in terms of the presentation, wording and structuring of the questions. In particular, questions were designed in an easy-to-understand and fill-in layout, while questions concerning similar issues (e.g. payroll expenses) were clustered together. The third section required respondents to report: whether they had availability of any of the six major ICT or elsewhere referred to as critical success ICT; and the type of use of each critical success ICT as previously presented. The fourth section aimed at gathering information regarding the availability and systems integration 28 ICT. In order to simplify the process of answering this question a figure was designed whereby a box representing the hotel PMS was located at the centre while all other ICT technologies (also illustrated within boxes) were placed around it. Respondents were asked to circle a box when the represented ICT was available as well as to draw lines amongst boxes when interfaces/integration amongst ICT existed. The structure of the figure (i.e. a box in the centre representing the PMS and satellite boxes representing other ICT systems) was developed so as to reflect the central role that PMS plays in the hotel ICT infrastructure. Moreover, in order to make the figure more comprehensible, boxes of ICT were clustered together based on the departments where they are found, e.g. boxes of F&B ICT were clustered together as were boxes representing ICT available in guest rooms.

The research instrument is provided in Appendix C.

When administering the questionnaire, the following actions were taken in order to ensure high response rate: include a pre-paid and pre-addressed envelope; include a covering letter (printed on a University's headed paper) explaining the scope and nature of the research in order to assure respondents of the value and importance of the research as well as the confidentiality of any data provided (this is provided in Appendix D); and questionnaires were coded in order to identify non respondents and conduct a follow up. The assurance of respondents regarding data confidentiality and the nature of the research was crucially important because of the sensitivity of the data required.

8.2.7 Sample design and selection

The principle of sampling is to select a part of some population to represent the whole population, whatever that may be. Careful selection is necessary in order to minimize bias and error (Alreck and Settle, 1985; Moser and Kalton, 1986; Marshall, 1997) and so to enhance the external validity or generalisability of the study. External validity attempts to address the researcher's ability to generalize the finding from his/her study beyond the cases used in the study. In other words, external validity defines the boundaries or domain for which the findings can be interpreted and applied (Kerlinger, 1986; Fink, 1995). Establishing a high degree of external validity helps to built credibility with the study and its findings.

The selection of a representative sample is mainly achieved by using a random sample taken from the study population, which in turn is required in order to eliminate sampling error. Where sample errors occur there are differences between the sample data and the population data purely by random chance. Thus, for statistical purposes, random sampling is most desirable, because the researcher can compute and report confidence intervals indicating the probability that the population average is within a certain range around the sample average (Alreck and Settle, 1985; Moser and Kalton, 1986). It is also possible to calculate and report the statistical significance of relationships between survey items based on the probability that such relationships would result only from sampling error. On the contrary, where random sampling is not used none of the statistical coefficients or values would be accurate or legitimate.

In this study in order to ensure external validity (generalisability) and to be able to use statistical tests the following procedure was followed. The sampling frame, i.e. a list of all units comprising the study's population, was identified. That was the list of three star hotels found in the AA hotel directory. A random sample of 300 three star hotels was initially compiled and targeted during June, 2000. Unfortunately, the response rate was extremely low, only five questionnaires were returned. A follow up to the same hotel database (excluding the five hotels that had responded) was conducted three weeks after the initial attempt, but this boosted the response rates little. Only seven additional questionnaires were received.

The very low response rates were mainly attributed to three factors: the generally very low response rates usually obtained from the industry (e.g. in their study Sigala et al, 1999) also reported low response rates from the three star hotel sector in UK); the reluctance of hoteliers to disclose sensitive information, which was also made evident during the pilot testing of the instrument, i.e. it was very difficult to find hoteliers to do the pilot, while a great majority of those that agreed to participate claimed that they would not have disclosed all required information; and the fact that a lot of small three star hotel properties do not to have formal procedures of gathering the required data. These arguments were confirmed when the questionnaire was sent to eleven hotels that were known to the researcher and her supervisory team and had agreed to take part in the study. Indeed, six out of eleven questionnaires were returned (i.e. 54.55% response rate), which indicated that a relationship and willingness of hoteliers to participate in the study was a vital factor for ensuring higher response rates.

Because of that, the study had to change strategy in terms of sample selection. Personal contacts with hotel chains, associations and consultancy firms conducting regular hotel productivity studies (and so that would have databases of hotels that regularly collect relevant information) were used in order to consolidate a representative database of hotels, which would in turn be very likely to have and be willing to release the required information. Ultimately, in order to ensure representation of different types of hotels, one contact with a leading three star hotel company also representing a substantial proportion of bed capacity in UK, one contact with a leading hotel consortium representing the greatest majority of independent three star hotel properties in UK and one of the three leading consultancy companies conducting regular hotel productivity surveys were used. Names are not disclosed for reasons of confidentiality.

In the case of the hotel chain and the hotel consortium the questionnaire was distributed through the organizations' own channels and forwarded by the managing directors (i.e. through the corporate e-mail list and the regular mail shots respectively), which increased credibility and possibilities to get responses. In the case of the consultancy company, fifteen three star hotel were identified from its database, which were directly contacted by the researcher as the consultancy firm's survey (that could have incorporated the researchers' instrument) had already been completed. However, the consultancy firm agreed for the researcher to use its name in the covering letter in order to increase rapport and credibility and so, establish a relationship with the hotels that were targeted.

Indeed, as illustrated in Table 8.2.7.a, response rates obtained through two out of the three organizations were substantially higher and satisfactory. The disappointing low response rate through the hotel consortium was mainly attributed to the bad period that the hotels were targeted, i.e. during the very busy Christmas period. Unfortunately, a follow up was not possible as the hotel consortium could not distribute the questionnaire again through its channel. However, the hotel consortium director agreed to circulate a reminder of the study to the consortium membership list, but this did not increase response rates. Finally, twelve more questionnaires were obtained from sixteen overall targeted hotels with which the researcher and the supervisory team had a personal contact.

Table 8.2.7.a Research sample and response rates

	Respondents*	**Target population**	**Response rate**
Random sample of 300 hotels, (June 2000)	5	300	1.67%
Follow up to the June's random sample	7	295	2.37%
Personal contacts (June 2000)	6	11	54.55%
Hotel chain (Novem- Decem, 2000)	32	43	74.42%
Hotel consortium (Decemb – Febr, 2000-2001)	18	382	4.71%
Database of consultancy firm (February 2001)	13	15	86.67%
Personal contacts (Febr - March 2001)	12	16	75.00%
TOTAL	93	1,062	8.76%

* number of usable returned questionnaires is illustrated

The whole process lasted from June 2000 to March 2001 and it was concluded that no further actions could be taken to boost response rates because: the best possible that could have been done was done; and a new financial year was soon starting, meaning that if further responses were going to be sought hotels would have to search and provide information regarding two financial years ago in order to ensure comparability with the data already gathered. This makes the completion of the questionnaire even more difficult.

Overall, despite the very low response rates from the different methods used, a total number of 1,062 three star hotels in UK were targeted giving a number of 93 usable questionnaires. Moreover, because of the different types of organizations contacted, the total number of 1,062 targeted hotels can be argued to be a quite representative sample of the three star hotel sector in UK consisting of 1,727 three star hotels according to data gathered from the British Hospitality Association's (BHA) website (2001).

8.2.8 Data analysis

Data analysis started with the calculation of simple and descriptive statistics in order to identify: the profile of respondents; an overall picture of their operational performance; and the respondents' ICT adoption rates and ICT implementation patterns. These findings are reported in the first section of the data analysis titled the Profile of Respondents. The latter also includes an investigation into the impact of demographic characteristics on productivity levels.

The next section of data analysis provides a detail analysis of the use of DEA in productivity measurement. For calculating productivity levels, the stepwise DEA approach was used in the rooms and F&B division and ultimately in the whole hotel property. According to the stepwise DEA methodology, initial DEA models incorporated aggregate financial metrics of inputs and outputs. The DEA ratio obtained was correlated (Pearson correlations) with partial productivity inputs and outputs as well as other contextual factors that could have affected productivity. When significant correlations were found, partial figures and factors were incorporated in the DEA model (so aggregated figures had to be disaggregated into relevant partial metrics) and productivity levels calculated again. When no more correlations were found, the DEA model represented a robust metric of productivity taking into consideration all factors affecting productivity. Ultimately, the factors identified to affect productivity in rooms division and F&B were used in order to construct the robust DEA model of hotel overall productivity. The statistical software used to perform all DEA calculations is called Frontier Analyst and it is developed by Banxia Ltd.

The third part of data analysis investigates the relationship between ICT and productivity as measured with the DEA. Three ICT metrics were calculated as previously presented: levels of ICT availability both of individual ICT and clusters of ICT; integration levels with PMS and among other ICT; and sophistication scores of the six critical success ICT. Inferential parametric statistics (t-test, ANOVA and Pearson correlations) were conducted using the SPSS software (version 10.1) in order to investigate any relationships between productivity levels and ICT metrics.

Inferential parametric statistics (t-test, ANOVA and Pearson correlations) were also used in order to investigate whether any factors relating to the characteristics of respondents namely location, hotel design, ownership structure, management arrangement, market segments served by the hotel as well as types of distribution channels of hotel reservations affected productivity levels.

However, Cramer (1994) argued that parametric tests should only be applied when the data fulfil three conditions: the variables are measured with an equal interval or ratio scale; and the samples are drawn from populations; whose variances are equal or homogeneous; and whose distributions are normal.

Data of this study fulfil the first condition. With respect to the second and third proposition, a number of studies have been conducted investigating the effect that samples drawn from non-normal distributions and with unequal variances have on the values of parametric tests (e.g. Boneau, 1960). Violation of these two assumptions generally had little effect on the values of these tests. One exception to this finding was where both the size of the samples and the variances were unequal. In such circumstances, the use of non-parametric tests is suggested (Tabachnick and Fidell, 1989). In this vein, when parametric tests were used in this study, the size of the samples and the variances were checked and when both were found to be unequal non-parametric tests (Mann Whitney U test or Kruskal- Wallis H, depending on the number of groups) were used as well.

The Mann-Whitney U test determines the number of times a score from one of the samples is ranked higher than a score from the other sample. If the two sets are similar, then the number of times this happens should be similar for the two samples.

The Kruskal-Wallis H test is similar to the Mann-Whitney U test in that the cases in the different samples are ranked together in one series except that this test can be used with more than two unrelated samples.

Research findings are reported in chapter nine.

8.3. Conclusions

The purpose of this study is two fold. First, to assess the impact of ICT on productivity in the three star hotel sector in the UK by proposing and implementing a robust methodology that overcomes previous identified problems relating to the ICT productivity paradox. Second, the study aims to contribute and extend knowledge on the fields of ICT and productivity. To achieve this, a robust research design and methodology were developed after reviewing and analyzing literature in three core fields namely ICT, productivity and DEA. The research framework was designed in order to overcome previous identified methodological limitations of past studies investigating the ICT productivity paradox. Specifically, the research design of this study is summarized as follows:

- focus of analysis:
    - aspect of performance: productivity
    - unit of analysis: hotel but also departmental level; individual ICT applications and cluster of ICT applications;
    - locus of timing: cross-sectional study simulating longitudinal research
    - role of IS performance: use of ICT metrics reflecting exploitation of ICT
- measurement caveats:
    - reliability of performance and ICT measurement: consideration of multiple inputs/outputs affecting productivity through the use of stepwise DEA; consideration of core ICT features affecting ICT benefits
    - mode of analysis: stepwise DEA at departmental and hotel level
    - contextual factors: consideration of the impact of contextual factors through the stepwise DEA (for their impact on productivity) and

hypotheses testing (for their impact on the relationship between ICT and productivity).

Having identified the research framework research variables and constructs were identified and developed based on a interdisciplinary literature review, personal observations and experts views in order to ensure reliability and validity of the research. Because of the type and amount of data required, a questionnaire was developed and distributed through a mail survey targeting hotel managers of three star hotels. Data gathering presented several difficulties mainly due to the sensitive of the data, but after using personal contacts while taking care of sample representation issues, 93 useable questionnaires were returned. Findings and discussion on the research findings are provided in the following chapter regarding data analysis.

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Data analysis

The purpose of this chapter is to present and discuss the research finding as well as the procedures for obtaining them. Research data were analysed in order to answer the research objectives and questions as presented in the methodology chapter. Specifically, data were analysed in the following sections:

- Descriptive data regarding the demographic profile of respondents in order to get an insight of our sample;
- Descriptive data regarding the ICT applications that the study respondents had adopted and used;
- Detailed analysis on how productivity has been measured by the stepwise DEA approach;
- Investigation of the impact of demographic characteristics on productivity;
- Detailed analysis on the investigation of the impact of ICT on productivity levels; specifically, relationships between the three ICT metrics and the different productivity scores obtained by the DEA methodology were examined.

9.1 Profile of the respondents

9.1.1 Response rate

As explained in the research methodology section, the mail survey targeting a random sample of three star hotels produced very low response rates. As a result personal contacts with hotels, consultancy and hotel chain and consortia were used in order to boost responses. The structure and response received by the different ways are illustrated in Table 9.1.1.a below.

Table 9.1.1.a Research sample and response rates

	Respondents*	Target population	Response rate
Random sample of 300 hotels, (June 2000)	5	300	**1.67%**
Follow up to the June's random sample	7	295	**2.37%**
Personal contacts (June 2000)	6	11	**54.55%**
Hotel chain (Novem- Decem, 2000)	32	43	**74.42%**
Hotel consortium (Decemb – Febr, 2000-2001)	18	382	**4.71%**
Database of consultancy firm (February 2001)	13	15	**86.67%**
Personal contacts (Febr - March 2001)	12	16	**75.00%**
TOTAL	93	1,062	**8.76%**

* number of usable returned questionnaires is illustrated

Overall, despite the very low response rates from the different methods used, a total number of 1,062 three star hotels in UK were targeted giving a number of 93 usable questionnaires. Moreover, the total number of 1,062 targeted hotels (that also represented different types of organizations) can be argued to be a quite representative sample of the three star hotel sector in UK that is consisted of 1,727 three star hotels according to data gathered from the British Hospitality Association's (BHA) website (2001).

9.1.2 Demographic characteristics of respondents

The following analysis describes the profile of respondents regarding their management arrangement, ownership structure, location, hotel design and size of operation

Data were gathered from a balanced sample in terms of the respondents' ownership structure. Indeed, 51.6% of the respondents were independently owned with the rest owned by a hotel chain. However, as concerns the management arrangement of respondents, as a great majority represents chain managed hotels (50.5%), fewer respondents were independently managed (30.11%), while there is a small representation (19.35%) of independently managed hotels that are also consortia members (Table 9.1.2.a). This sample structure is partly influenced by the method of data collection that had to be followed for overcoming the problems regarding the low response rates.

Table 9.1.2.a Ownership structure and management arrangement of respondents

Ownership structure	N	%	Management arrangement	N	%
Independently owned	48	51.61	Independent management	28	30.11
Chained owned	45	48.39	Chain management	47	50.54
			Independent management & consortia membership	18	19.35
Total	**93**	**100.00**	**Total**	**93**	**100.00**

The location and design of responding hotels are given in Table 9.1.2.b. Although a great majority of respondents represents city centre located (39.7%) and purpose built hotels (39.7%), the response sample can be argued to be quite balanced. Indeed, 34.4% and 25.8% of hotels correspond to hotels located in rural and in suburban areas respectively, while 33.3% and 26.7% of respondents were old and/or traditional and redesigned/converted hotels.

Table 9.1.2.b Location and building design of respondents

Location	N	%	Design	N	%
Rural	32	34.40	Old and/or traditional	31	33.33
City centre	37	39.78	Redesigned/converted	25	26.88
Suburban	24	25.81	Purpose built	37	39.79
Total	**93**	**100.00**	**Total**	**93**	**100.00**

Statistics in Table 9.1.2.c provide data concerning the size of operations of respondents. Responses were gained from hotels with a wide range of room (min=18, max=283 rooms) and FB capacity (min=0, max=300 restaurant seats and max=600 banqueting covers). However, a skewness metric around the value of one for the distribution of rooms and banqueting capacity indicated that a great majority of respondents represented hotels with metrics below the sample mean, i.e. 90.4 rooms, 181.53 bedspaces and 191.31 banqueting covers. Concerning restaurant capacity, responses were gathered from hotels that were closely normally distributed (skewness near the 0 value) with many of them close to the mean value, i.e. 109.4 seats, (kurtosis=1.79).

Employee statistics revealed a similar pattern regarding the scale of operation of respondents. Responses were drawn from a wide range of scale of hotel operations (min=4, max=143 full time employees and min=2, max=155 part time employees). However, the spread of the number of employees within the response sample is different for full time and part time employees. A nearly zero kurtosis of a relatively positive skewed distribution of full time employees indicated that many respondents employed slightly fewer than 50.8 employees, i.e. the mean value, while a great positive kurtosis and skewness of the distribution of the number of part time employees indicated that many respondents had around 38.9 part-time employees, i.e. the mean value. These statistics are not surprising since hotels use make use of numerical flexibility to alleviate operational problems due to fluctuations in business.

Indeed, statistics in Tables 9.1.2.c and 9.1.2.d confirm this argument. In the distribution of the part time to full time ratio, a great positive kurtosis of a positively skewed distribution revealed that many respondents had a ratio of part time to full time employees slightly less than 1.02, i.e. the mean value, meaning that they employed as many part time as full time employees. On the contrary, the distribution of total payroll paid to full time staff had a kurtosis of nearly zero and a small negative skewness indicating a wide spread of the metric and that for relatively many respondents more than 60.35% of the payroll, i.e. the mean value, is paid for full time employees. The fact that the number of part timers equals with the number of full timers while the spread of the percentage of payroll paid to full timers was found to be wide reflects the fact that hotels had been using a great number of staff but for less hours than the full time staff in order to alleviate problems due to demand fluctuations.

Overall, respondents employed on average 9.1 managers and/or heads of department. The distribution of the number of managers and/or heads of department was closely normally distributed (skewness=0.57 and kurtosis=-0.06), which is in contrast with the positive or negative skewed distributions of metrics indicating the rooms and FB capacity of respondents. This illustrates that the number of staff at the high level of the hierarchy is not related with the scale of operations. Thus, other factors of operational and management arrangements have influenced the number of staff at managerial positions.

Great values of skewness and kurtosis of the distribution of the number of IT staff indicated that many respondents employed fewer than 1.2 IT staff, i.e. the mean value, meaning that a great majority of respondents did not have any full time IT staff in their properties.

Table 9.1.2.c Distribution characteristics of metrics indicating the size of operation of respondents

Number of:	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Rooms	18	283	90.419	65.005	1.100	0.250	0.615	0.495
Bedspaces	36	611	181.537	132.070	1.254	0.250	1.325	0.495
Restaurant seats	0	300	109.408	48.316	0.878	0.250	1.795	0.495
Banqueting covers	0	600	191.311	149.823	1.273	0.250	1.136	0.495
Full time employees	4	143	50.817	38.012	0.948	0.250	0.011	0.495
Part time employees	2	155	38.924	35.441	1.835	0.250	3.020	0.495
Managers and/or head of departments	0	26	9.150	6.017	0.571	0.250	-0.067	0.495
IT staff	0	3	1.268	4.477	5.369	0.250	43.278	0.495

Table 9.1.2.d Part time staff as a percentage of full time staff (1) and percentage of total payroll paid for full time staff (2)

	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
(1)	0.1111111	4.666	1.024	0.986	2.106	0.250	4.415	0.495
(2)	18	90	61.354	16.786	-1.060	0.250	0.753	0.495

9.1.3 Operational characteristics of respondents

As the following operational characteristics can impact on productivity, hotels were asked to provide data regarding: their allocation of staff among departments and between part and full time staff; type of market segment served; and use of distribution channels. The profile of respondents regarding these features is analysed as follows.

Metrics regarding the distribution of the number of full time employees per hotel department are given in Table 9.1.3.a. For the majority of the distributions, skewness, kurtosis and standard deviation statistics are of high values, indicating great deviations from normal distributions. This is though expected since the response sample was drawn from hotels from a wide scale of operations. On the other hand, because of the wide size range of respondents, raw data on the number of employees cannot be used in order to identify a pattern in terms of the breakdown of full time staff in different hotel departments. To that end, the number of full time staff within every department was divided by the total number of full time staff for each of the respondents (in order to take into account the different size of operation of the respondents) and statistics of the distribution of these percentages at this time were calculated (Table 9.1.3.b).

Table 9.1.3.a Distribution of the number of full time employees per hotel department

Number of full time employees per hotel department	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Front office	2	21	7.322	4.818	1.094	0.250	0.301	0.495
Housekeeping	0	34	8.989	8.510	1.452	0.250	1.352	0.495
Food & Beverage	1	56	20.000	14.704	0.803	0.250	-0.503	0.495
Telephone	0	6	0.451	0.994	2.912	0.250	10.651	0.495
Administration & General	0	29	5.193	4.965	2.469	0.250	8.470	0.495
Marketing & Sales	0	13	2.215	3.332	1.653	0.250	1.697	0.495
Minor Operations	0	10	2.838	3.603	0.831	0.250	-0.862	0.495
Maintenance	0	6	1.913	1.529	0.762	0.250	-0.018	0.495
Other	0	34	3.260	7.886	2.713	0.251	6.810	0.497

As the standard deviations from the mean are now quite low (Table 9.1.3.b), the value of the means can be used in order to describe the profile of the respondents regarding the breakdown of their full time employees per hotel department. Thus, the greatest percentage of full time staff is found in the FB division (42%), smaller percentages of staff are employed in the Front Office and Housekeeping department (17.7% and 17.4% respectively), a smaller percentage of full time staff (10.7%) is found in the Administration & General department, while very small percentages of full time staff are employed in the Minor Operations (0.04%), Other (0.045%), Maintenance (0.037%), Marketing & Sales (0.031%), and Telephone (0.005%) departments. However, the standard deviations of the distribution of the percentages of full time employees in the FB and Telephone departments were high relative to their mean values and as great skewness and kurtosis values were also found, it can be argued that many respondents had a percentage of full time employees in these departments substantially lower than the mean value. The great deviations from the mean may illustrate that many respondents might have been using numerical flexibility in the FB department while in the Telephone department it is more reasonable to argue that many hotels might had been employing multiskilling between Front Office, Telephone and Marketing & Sales staff.

Table 9.1.3.b Statistics of the distribution of the percentages of full time employees per hotel department

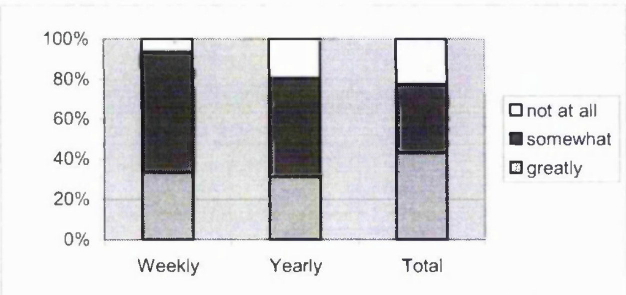
% of full time employees per hotel department	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Front office	0.063	0.600	0.177	0.092	1.965	0.250	5.323	0.495
Housekeeping	0.000	0.375	0.174	0.082	0.245	0.250	-0.191	0.495
Food & Beverage	0.100	1.238	0.421	0.174	2.251	0.250	8.192	0.495
Telephone	0.000	0.046	0.005	0.010	2.156	0.250	4.505	0.495
Administration & General	0.000	0.277	0.107	0.058	0.529	0.250	0.400	0.495
Marketing & Sales	0.000	0.136	0.031	0.040	1.200	0.250	0.239	0.495
Minor Operations	0.000	0.227	0.041	0.052	1.066	0.250	0.420	0.495
Maintenance	0.000	0.095	0.037	0.023	0.033	0.250	-0.073	0.495
Other	0.000	0.380	0.045	0.099	2.133	0.251	3.202	0.497

The use of numerical flexibility and multiskilling is not surprising since hotel operations face great fluctuations in their demand patterns. Indeed, research findings confirmed that a great majority of respondents (43%) operated under great variations in their business (Table 9.1.3.c). Actually, a great majority of respondents claimed to face somewhat variations in their business within the week (60.21%) and within the year (49.46%), but the combination of business variability within the week and within the year results in greater complexities that need to be managed overall. Indeed, when the total business variation was calculated by multiplying weekly with annual variation, a great majority of respondents 43% faced high fluctuations, a lower percentage (34.4%) faced somewhat fluctuations while only 22.5% was found not to have fluctuations at all. When data are plotted in a stacked column figure (Figure 9.1.3.a) it becomes evident that for many hotels, the business variations within the week are greater than business variations within the year, meaning that the former have contributed more than the latter in terms of total business variation.

Table 9.1.3.c Fluctuations in business within the week, the year and total

	Business variations within the week		Business variation within the year		Total business variation	
	No	%	No	%	No	%
Greatly	31	33.333	29	31.182	40	0.430
Somewhat	56	60.215	46	49.462	32	0.344
Not at all	6	6.451	18	19.354	21	0.225
Total	93	100.000	93	100.000	93	100.000

Figure 9.1.3.a Contribution of weekly and yearly business variation in total business variation



Different types of hotel guests can result in different fluctuations in business as well as they entail different operation processes and so, efficiencies. In this vein, the following statistical data regarding the market segments served were gathered. For a great majority of respondents (since low skewness and kurtosis values are found) 36.9%, (mean value), of their roomnights are from repeat customers, while the quite high standard deviation indicates that for some hotels this percentage may vary greatly (Table 9.1.3.d). The quite normal distributions of the percentages of roomnights from business, leisure, conference and other guests (skewness and kurtosis values nearly zero), also suggest that for a great majority of respondents, the greatest percentage (47.15%) of their annual roomnights come from business travellers, a lower percentage (36.84%) represents leisure guests, an even smaller percentage (11.83%) corresponds to conference guests while a very small percentage (4.34%) represents other guests (Table 9.1.3.e).

Table 9.1.3.d Percentage of roomnights from repeat customers

Percentage of roomnights from:	**Min**	**Max**	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Repeat customers	9	80	36.946	18.990	0.440	0.250	-0.725	0.495

Table 9.1.3.e Statistics of the distribution of the percentages of roomnights per type of guest

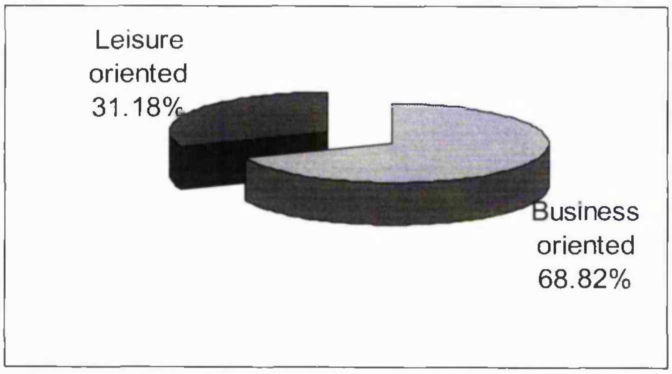
Percentage of roomnights from:	**Min**	**Max**	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Business guests	0	90	47.153	21.349	-0.347	0.250	-0.800	0.495
Leisure guests	2	90	36.841	23.810	0.866	0.250	-0.407	0.495
Conference guests	0	47	11.831	10.464	1.124	0.250	0.954	0.495
Other guests	0	50	4.344	8.229	3.098	0.250	11.797	0.495

However, because standard deviations in Table 9.1.3.e were found to be quite high relative to their mean value, meaning that some hotels greatly deviated from the sample mean, a detailed breakdown of the percentages of roomnights representing each type of guest is also given in Table 9.1.3.f. Business guests represent 51% to 75% of the annual roomnights for the greatest majority of hotels (41.9%), while leisure guests represent only 1% to 25% annual roomnights for the greatest majority of hotels (45.1%). As a result, the greatest majority of hotels gets only 1% to 25% annual roomnights from conference guests. Thus, data again revealed that the majority of respondents are oriented towards the business market. Indeed, for the 68.82% of respondents business guests represent more annual roomnights that leisure guests (Figure 9.1.3.b).

Table 9.1.3.f Detailed breakdown of the percentages of roomnights per type of guest

Type of guests	**Business guests**		**Leisure guests**		**Conference guests**		**Other guests**	
% of roomnights	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
0%	0	0.000	0	0.000	11	11.828	52	55.914
1% -25%	21	22.581	42	45.161	69	74.194	36	38.710
26% -50%	27	29.032	28	30.108	13	13.978	5	5.376
51%- 75%	39	41.935	14	15.054	0	0.000	0	0.000
76% - 100%	6	6.452	9	9.677	0	0.000	0	0.000
Total	93	100.000	93	100.000	93	100.000	93	100.000

Figure 9.1.3.b Market orientation of respondents



Reservations taken through different distribution channels also entail different operation processes as well as involve different costs, and so, respondents were also profiled regarding this issue (Table 9.1.3.g). As quite normal distributions and low standard deviations relative to their mean value were found for the percentage of reservations taken through property owned system and through third parties, it can be said that many respondents received on average 69.4% of their reservations through their owned system and the 26.6% through third parties. Thus, on average Internet reservations represented only a small percentage (3.4%) of total reservations, but the high standard deviation indicated great deviations from the mean value. However, the high positive kurtosis and skewness values indicated that for a great majority of respondents, the percentage of the Internet reservations was slightly lower than the mean value, i.e. 3.4% of the total reservations. Detailed statistics of the breakdown of reservations through each distribution channel lead to the same conclusions (Table 9.1.3.h).

Table 9.1.3.g Statistics of the distribution of the percentage of reservations taken per distribution channel

% of reservations taken through:	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Property owned system	37	90	69.467	12.237	-0.450	0.250	-0.469	0.495
Third parties	5	62.8	26.658	12.088	0.365	0.250	-0.106	0.495
Internet	0	20	3.411	4.215	1.682	0.250	2.845	0.495

Table 9.1.3.h Detailed breakdown of the percentages of reservations per distribution channel

Type of distribution channel	Property owned system		Third parties		Internet	
% of reservations	N	%	N	%	N	%
0%	0	0.000	0	0.000	25	26.881
1% -25%	0	0.000	49	52.688	68	73.118
26% -50%	8	8.602	40	43.010	0	0.000
51%- 75%	51	54.838	4	4.301	0	0.000
76% - 100%	34	36.559	0	0.000	0	0.000
Total	93	100.000	93	100.000	93	100.000

9.1.3.1 Profiling respondents on their productivity output metrics

Output metrics (both aggregate and partial) regarding respondents' performance for the financial year ending in 1999 are provided in Table 9.1.3.1.a. The spread and standard deviations from the mean of the metrics are high, but which is not surprising when considering that respondents represented hotels from a wide scale of size of operations. Specifically, regarding performance in rooms division for the financial year examined, respondents got 23,305 roomnights on average, while the high positive skewness and standard deviation indicated that many respondents got an annual number of roomnights lower than the average. Number of roomnights achieved is not only influenced by scale of operation but by occupancy rates as well. Overall, respondents claimed to have achieved an average occupancy rate of 70%, while the small negative skewness value and the high standard deviation indicated that many respondents achieved occupancy rates little higher than the mean. The average length of stay of respondents' guests was found to be 2.0 days, however the high standard deviation and positive skewness and kurtosis values, indicated that for a great majority of respondents the average length of stay was little lower than the mean. This is not surprising though when considering the high percentages of annual roomnights from the business travellers and the high weekly variations in business claimed by respondents. The average ARR achieved was £58.5, but the high values in standard deviation, skewness and kurtosis, indicated that many respondents achieved an ARR of a smaller value than the mean.

In the FB division, the average number of restaurant and banqueting covers served was found to be 63,602 and 18,308 covers respectively, but again the high positive values of the standard deviations, skewness and kurtosis, revealed that a substantial majority of respondents served a smaller number of restaurant and banqueting covers than the mean.

Overall, the average annual total revenues and annual total profit before fixed charges were found to be £2,711,802 and £896,516 respectively. However, a great majority of respondents achieved annual total revenue and profit below the sample average since high positive values in standard deviation, skewness and kurtosis distribution statistics were found.

Table 9.1.3.1.a Statistics of the distribution of output metrics

Output metric	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
No. of roomnights	3650	74600	23305.43	18035.24	1.17	0.250	0.658	0.495
Occupancy (%)	40	90	70.00	10.55	-0.70	0.250	0.279	0.495
Length of stay (days)	1	6	2.04	0.80	3.01	0.250	11.551	0.495
ARR (£)	34	200	58.54	22.18	3.49	0.250	17.764	0.495
No. of restaurant covers served	0	395000	63602.68	67202.60	2.73	0.250	10.292	0.495
No. of banqueting covers served	0	202000	18308.89	31715.37	4.33	0.250	22.686	0.495
Annual total revenue (£)	556081	8350617	2711802	1618719	1.20	0.250	1.616	0.495
Annual total profit before fixed charges (£)	90000	5713965	896516.4	976343.4	2.30	0.250	6.648	0.495

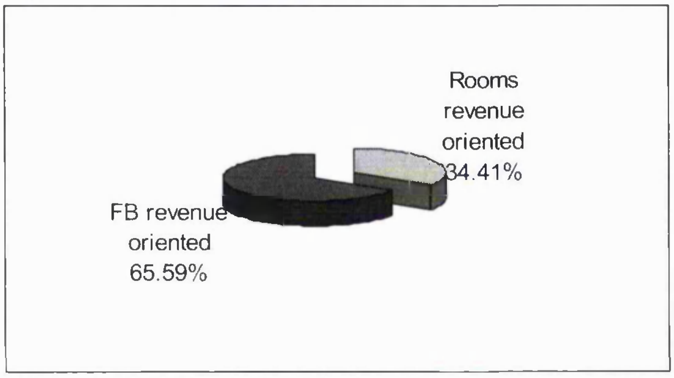
Table 9.1.3.1.b provides statistics regarding the contribution of hotel departments in total revenue. On average, the revenue breakdown of the respondents is as follows:

the greatest proportion (52.2%) of respondents' revenue came from the FB department, a smaller proportion (43.3%) of total revenue was from the Rooms Division department, while the Minor operations and Telephone department made significant smaller contributions to the hotel revenue, (6.63% and 1.29%). The low values of skewness and kurtosis in the FB and Rooms Division department revealed that relative normal distribution of the contribution of the Rooms and FB division in total revenue. However, the high positive values in the standard deviations, skewness and kurtosis revealed that for many respondents the contribution of the last two departments in their total revenue was smaller than the mean. Moreover, the FB revenue orientation of respondents is also confirmed by the fact that 65.59% of the respondents achieved a substantially higher revenue from their FB department than the rooms division (Figure 9.1.3.1.a).

Table 9.1.3.1.b Statistics of the distribution of departmental revenues as a percentage of total revenue

Departmental revenue as a % of total revenue	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Rooms division	17	80	43.358	12.056	0.063	0.250	0.408	0.495
FB	15	85	52.533	13.218	-0.077	0.250	0.406	0.495
Minor operations	0	30	5.042	6.631	1.773	0.250	2.799	0.495
Telephone	0	10.7	1.039	1.294	4.942	0.250	34.178	0.495

Figure 9.1.3.1.a Revenue orientation of respondents



9.1.3.2 Profiling respondents in their productivity input metrics

In order to understand the input (cost) structure of respondents, the following analysis and statistics are provided.

Raw data regarding respondents' performance in input (financial expenses) metrics (both aggregate and partial) are provided in Table 9.1.3.2.a. It is interesting to highlight that the minimum value for some inputs was found to be zero meaning that some hotels did not have some operations, e.g. minor operations, or did not employ some staff, e.g. telephone, administration, indicating the input of personal/owner work. However, due to the wide range of scale of operation of respondents (reflected in the high values of standard deviations, skewness and kurtosis), raw data do not again reveal a lot regarding the distribution of inputs per hotel department and type of expense. Thus, the contribution (percentage) of each type of input (both in terms of the type of expense and type of hotel department) in its relevant aggregate input metric was calculated.

Table 9.1.3.2.a Statistics of the distribution of hotel aggregate and partial inputs per type of expense and hotel department

Type of expense	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Material & Other expenses								
Front office	880	467000	68048.5	100782.3	1.815	0.252	2.763	0.500
Housekeeping	2180	294000	60177.8	64213.8	1.502	0.250	1.809	0.495
Telephone	860	132450	14367.3	21601.9	3.059	0.250	11.050	0.495
Minor Oper.	0	451800	31462.5	63716.2	4.287	0.250	23.702	0.495
Adm. & Gen.	1100	1120000	126005.1	216614.5	2.787	0.250	7.864	0.495
Mark & Sales	0	161351	37772.5	38536.5	1.281	0.252	1.562	0.500
Rooms Division	**10300**	**1370000**	**339212.5**	**301631.6**	**0.992**	**0.255**	**0.606**	**0.505**
FB	**18000**	**1286000**	**337660.2**	**285373.1**	**1.734**	**0.250**	**2.586**	**0.495**
Maintenance	0	1640000	100939.1	186896.7	6.329	0.250	50.493	0.495
Other	0	450000	30769.1	92175.5	3.362	0.250	10.605	0.495
TOT.M.O	**130190**	**2907100**	**898605.4**	**583408.5**	**0.811**	**0.254**	**0.478**	**0.502**
Payroll expenses								
Front office	4000	382000	124530.5	86746.2	0.780	0.250	-0.149	0.495
Housekeeping	0	370700	129006.2	97193.5	0.979	0.250	0.217	0.495
Telephone	0	346780	6819.8	36330.0	9.106	0.250	85.863	0.495
Minor Oper.	0	258000	35600.1	53843.0	1.883	0.250	4.356	0.495
Adm. & Gen.	0	356789	117797.5	95394.4	0.792	0.250	-0.312	0.495
Mark & Sales	0	305870	30590.4	66154.1	3.551	0.250	11.832	0.495
Rooms Division	**75618**	**1241757**	**444344.6**	**288010.5**	**0.967**	**0.250**	**0.882**	**0.495**
FB	**20881**	**1340870**	**400345.1**	**301464.8**	**1.404**	**0.250**	**1.345**	**0.495**
Maintenance	0	960000	36997.9	100011.8	8.734	0.250	81.081	0.495
Other	0	450000	16849.4	77577.8	4.657	0.250	20.681	0.495
Total payroll	**178881**	**2460300**	**899811.5**	**465702.3**	**1.025319**	**0.250**	**1.023**	**0.495**
Other expenses								
Energy costs	4450	346780	84340.0	95355.2	1.227	0.250	0.257	0.495
Mangmt. fees	0	144000	4817.2	24232.9	5.311	0.250	27.134	0.495
IT training costs	0	106527	3503.5	13938.4	5.958	0.250	38.938	0.495
[redacted]								

Distribution of Material & Other expenses

Concerning the contribution of Departmental Material & Other (M&O) expenses towards total hotel Material & Other expenses (Table 9.1.3.2.b), it is revealed that on average the greatest proportion (44.5%) of total M&O expenses are from the FB division while smaller proportion (34.4%) is attributed to the Rooms division. This is not surprising, when considering the FB revenue orientation of the majority of respondents. Within the rooms division particularly, the highest contribution (13.11%) to total M&O expenses is from Administration & General expenses, a smaller contribution (7.3%) is from the housekeeping department, Front Office expenses accounted for the 5.8%, while the contributions of expenses from other departments were smaller than 5%. A significant contribution to total M&O expenses is from maintenance expenses (9.9%), which is not surprising when considering that 33.3% of respondents represented old and/or traditional properties and 26.8% had redesigned/converted their properties.

Table 9.1.3.2.b Statistics of the distribution of Departmental Material & Other expenses as a percentage of total hotel Material & Other expenses

Type of expense	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Material & Other expenses								
Front office	0.676	0.299	0.058	0.075	1.519	0.255	1.465	0.505
Housekeeping	1.675	0.286	0.073	0.058	1.126	0.252	1.716	0.500
Telephone	0.661	0.149	0.015	0.019	4.094	0.252	25.554	0.500
Minor Oper.	0.000	0.200	0.023	0.038	2.170	0.252	5.261	0.500
Adm. & Gen.	0.845	0.662	0.131	0.170	1.625	0.254	1.926	0.502
Mark & Sales	0.000	0.157	0.042	0.037	0.911	0.254	0.326	0.502
Rooms Division	**0.016**	**0.796**	**0.344**	**0.194**	**0.377**	**0.255**	**-0.568**	**0.505**
FB	**0.021**	**0.983**	**0.445**	**0.259**	**0.373**	**0.254**	**-1.020**	**0.502**
Maintenance	0.000	0.564	0.099	0.100	1.869	0.254	4.948	0.502
Other	0.000	0.352	0.025	0.069	2.960	0.251	8.450	0.497
Total M&O	1	1	1	0	0	0	0	0

When the contribution of individual rooms division M&O expenses to rooms division M&O expenses is calculated a similar pattern in cost contributions is revealed again (Table 9.1.3.2.c), i.e. Administration & General expenses accounted for the greatest percentage, followed by Housekeeping expenses, then Front Office, Marketing & Sales, Minor Operations, while Telephone expenses accounted for the smallest contribution.

Table 9.1.3.2.c Statistics of the distribution of individual material & other expenses as a percentage of total rooms division material & other expenses

Type of expense	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Material & Other expenses								
Front office	8.54E-02	0.775	0.160	0.171	1.371	0.255	1.542	0.505
Hous/kng	0.2116505	0.888	0.278	0.231	0.872	0.254	-0.115	0.502
Telephone	8.35E-02	0.271	0.056	0.060	1.644	0.254	2.503	0.502
Minor Oper.	0.106	0.607	0.065	0.121	2.851	0.252	9.075	0.500
Adm. & Gen.	0	0.938	0.302	0.292	0.698	0.255	-0.957	0.505
Mark & sales	0	0.508	0.130	0.116	1.187	0.255	1.247	0.505
Total M&O expenses in Rooms Division	1	1	1	0	0	0	0	0

Distribution of Payroll expenses

Regarding the breakdown of total payroll expenses into departmental expenses the following data in Tables 9.1.3.2.d and 9.1.3.2.e are provided. In contrast to M&O expenses, rooms division (50.2%) and not the FB division (45.03%) payroll expenses constitute the highest proportion of total payroll expenses. This however might not be surprising when considering that the rooms division consists of a greater variety of departments (and so a greater number of minimum staff that has to be employed at any time), which also results in greater complexities to be managed, which are further multiplied when great business varies a lot. Front Office payroll makes the third highest contribution to total payroll (15.78%), while the contributions of housekeeping (14.9%), Administration & General (13.11%), Minor (3.39%), and Marketing & Sales (2.53%) follow with the Telephone payroll contributing the least (0.4%). It seems thus, that the telephone function is the one benefiting hotels the most through staff multiskilling techniques. Maintenance again makes a significant contribution with its payroll accounting for the 3.5% of total payroll.

Table 9.1.3.2.d Statistics of the distribution of Departmental payroll expenses as a percentage of total hotel payroll expenses

Type of expense	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Payroll expenses								
Front office	0.012	0.648	0.157	0.121	1.297	0.250	1.783	0.495
Housekeeping	0	0.558	0.149	0.103	1.366	0.250	4.126	0.495
Telephone	0	0.200	0.004	0.021	8.743	0.250	81.006	0.495
Minor Oper.	0	0.292	0.033	0.053	2.290	0.250	7.152	0.495
Adm. & Gen.	0	0.461	0.131	0.087	0.725	0.250	0.858	0.495
Mark & Sales	0	0.180	0.025	0.038	2.633	0.250	6.984	0.495
Rooms Division	**0.082**	**0.851**	**0.502**	**0.211**	**-0.345**	**0.250**	**-1.184**	**0.495**
FB	0.044	0.917	0.450	0.222	0.445	0.250	-0.989	0.495
Maintenance	0	0.537	0.0355	0.057	7.548	0.250	66.064	0.495
Other	0	0.299	0.011	0.051	4.775	0.250	22.874	0.495
Total payroll	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**

The pattern of payroll costs contributions within the rooms division is similar as when individual payroll expenses are expressed as a percentage of the total rooms division payroll (Table 9.1.3.2.e).

Table 9.1.3.2.e Statistics of the distribution of Departmental payroll expenses as a percentage of total rooms division payroll expenses

Type of expense	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Payroll expenses								
Front office	0.029	0.761	0.316	0.170	0.431	0.250	-0.656	0.495
Hous/kng	0	0.806	0.309	0.147	0.950	0.250	2.544	0.495
Telephone	0	0.279	0.007	0.029	8.463	0.250	77.356	0.495
Minor Oper.	0	0.439	0.060	0.094	1.928	0.250	3.925	0.495
Adm. & Gen.	0	0.616	0.260	0.129	0.061	0.250	-0.114	0.495
Mark & sales	0	0.274	0.046	0.065	2.184	0.250	4.426	0.495
Total Payroll expenses in Rooms Division	1	1	1	0	0	0	0	0

Distribution of total hotel expenses in payroll, M&O, energy, training on IT expenses and management fees

As concerns the contribution of M&O expenses and payroll expenses to total hotel expenses, Table 9.1.3.2.f illustrates that payroll expenses accounted for the greatest proportion (52.61%) of total respondents' expenses with M&O expenses at 47.3%, which was expected because of the labour intensiveness of the hotel sector. The labour intensiveness is higher in the Rooms than the FB division, because: a) as Table 9.1.3.2.d illustrates, Rooms division payroll accounted for the 50.2% of hotel payroll while FB payroll accounted for a lower percentage (45%) of total hotel payroll; and b) because as Table 9.1.3.2.b illustrates Rooms division M&O expenses represent the 34.4% of the total M&O hotel expenses, while the FB M&O expenses represent a higher percentage (44.5%) of total hotel M&O expenses. This is not surprising though since inherently the FB division involves a lot of M&O expenses.

Table 9.1.3.2.f Total payroll and Total material & other expenses as a percentage of total hotel expenses

	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Total Payroll	0.309	0.819	0.526	0.107	0.691	0.254	0.282	0.502
Total M&O	0.180	0.690	0.473	0.107	-0.691	0.254	0.282	0.502

However, when energy, IT training costs and management fees are identified separately from the total M&O costs (Table 9.1.3.2.g), it is revealed that they only make a small contribution towards total hotel expenses, i.e. 4.1%. 0.1% and 0.2% respectively. It is interesting to highlight the very low expenses provided for training in IT, while the very small contribution of management fees in total expenses is explained when considering that of the 51% respondents that were managed by an hotel chain 48.3% were also owned by the chain.

Table 9.1.3.2.g Energy costs, management fees and IT training costs as a percentage of total hotel expenses

	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Energy costs	0.01	0.155	0.041	0.037	1.116	0.254	0.618	0.502
Magmnt fees	0	0.079	0.002	0.012	4.889	0.250	24.261	0.495
IT training costs	0	0.028	0.001	0.004	5.208	0.251	30.131	0.497

9.1.4 Respondents' profile on ICT metrics: adoption, integration and usage sophistication levels

The following analysis provides data regarding respondents' adoption of different ICT, the integration and the degree of sophistication of use of available ICT.

9.1.4.1 Adoption and integration levels of ICT

Adoption and PMS integration of single ICT

Adoption rates of critical success ICT are provided in Table 9.1.4.1.a. E-mail and Website were found to be the two most heavily adopted critical success ICT, with almost all respondents claiming availability (97.8% and 94.6% respectively). A substantial proportion of respondents (83.9%) also had a PMS, while slightly fewer respondents (72%) claimed availability of a customer database. A small proportion of respondents (32.3%) had invested on Intranet systems, while Extranet systems were the least adopted technology (only five respondents claimed availability).

Table 9.1.4.1.a Adoption of critical success ICT

	No	%
E-mail	91	97.8
Website	88	94.6
PMS	78	83.9
Customer Database	67	72.0
Intranet	30	32.3
Extranet	5	05.4

However, apart from the Website and e-mail, the adoption rates of the other critical success ICT were not higher than the adoption rates of other ICT (Table 9.1.4.1.b). In particular, a great majority of respondents claimed availability of ICT in Rooms and FB division, but adoption rates of ICT in the former division were higher than the latter. A substantial proportion of respondents had also adopted two general ICT (namely, F&A systems and e-lock systems), while a very small proportion of respondents claimed availability of in-room ICT.

Regarding specific ICT, Front Office systems were the most heavily adopted ICT attracting 92.5% of the respondents, followed by Telephone (80.6%), PBRS (78.5%) and F&A systems (75.3%). A great majority of respondents also claimed availability of CRS (69.9%), EPOS (63.4%), YM (51.6%), Stock & Inventory (51.6%) and GDS (50.5%), while less than half of the respondents had invested on the other ICT. E-procurement, videoconferencing systems, smart cards and DSS accounted for the lowest adoption rates attracting 6, 5, 5 and 2 respondents respectively.

The integration level of each ICT was calculated by dividing the number of respondents claiming a link between the ICT and their PMS with the total number of respondents claiming ICT availability. In other words, the integration level indicates the proportion of respondents with ICT availability that had the ICT integrated with their PMS. Thus, the maximum potential integration level is 1, demonstrating that all ICT holders have their ICT PMS integrated. Integration levels are given in Table 9.1.4.1.b.

Table 9.1.4.1.b Adoption and integration levels of the 28 investigated ICT (ranked by increasing adoption rates within each group of ICT)

Type of ICT:	ICT availability		ICT integration	
	N	%	N	%
Rooms division ICT				
Front Office System	86	0.925	68	0.791
Telephone system	75	0.806	46	0.613
Property Based Reservation System (PBRS)	70	0.753	53	0.757
Customer Database	67	0.720	42	0.627
Central Reservation System	65	0.699	32	0.492
Yield Management	48	0.516	32	0.667
Global Distribution Systems	47	0.505	7	0.149
Marketing & Sales System (M&S)	41	0.441	26	0.634
Check in/out Kiosks	11	0.118	7	0.636
Smart cards	5	0.054	1	0.200
FB division ICT				
Electronic Point of Sale Systems (EPOS)	59	0.634	41	0.695
Stock & Inventory Systems	48	0.516	23	0.479
Food & Beverage (FB)	41	0.441	20	0.488
Conference & Banqueting Systems	33	0.355	19	0.576
In-room ICT				
In-room office facilities	36	0.387	0	0.000
Voice mail	30	0.323	3	0.100
TV based services	28	0.301	9	0.321
In-room Internet & e-mail access	28	0.301	6	0.214
On demand movies/games	26	0.280	7	0.269
Automated mini-bars	7	0.075	3	0.429
General ICT				
Finance & Accounting Systems (F&A)	73	0.785	52	0.712
Electronic Lock Systems	41	0.441	22	0.537
Human Resource Management Systems	18	0.194	1	0.056
Energy Management Systems	11	0.118	3	0.273
Management Support Systems (MSS)	8	0.086	2	0.250
e-procurement Systems	6	0.065	3	0.500
Videoconferencing Systems	5	0.054	0	0.000
Decision Support Systems (DSS)	2	0.022	2	1.000

ICT integration levels were lower than their adoption rates, meaning that not all respondents claiming ICT availability also had them integrated with their PMS (Table 9.1.4.1.b). This is not surprising when considering the piecemeal approach to ICT investments that most hotels had been following. Specifically, hotels with ICT in Rooms and FB division accounted for the greatest majority of ICT holders with PMS integrated ICT; in fact, ICT in Rooms division did not only account for higher adoption but also for higher integration rates than ICT in FB division. A great proportion of respondents having the two most heavily adopted general ICT had them also integrated, while all in-room ICT (apart from mini-bars) accounted for very low integration levels.

Concerning integration of specific ICT, Front Office systems corresponded for both the most heavily adopted and the most PMS integrated ICT; (DSS accounted for the maximum integration level, (1), but this finding is not reliable since only two respondents claimed both availability and PMS integration of the systems). However, when looking within each group of ICT, apart from the top most heavily adopted ICT which were also the most PMS integrated ICT, as concerns the other ICT, their integration levels do not follow the same ranking as their adoption rates. In other words, the most heavily adopted ICT were not always the most PMS integrated ICT. Regarding the integration of the critical success ICT, only 62.7% of hotels that claimed availability of a Customer Database reported to also have it integrated with their PMS system.

Adoption and PMS integration of clusters of ICT

Because of the synergy effect that ICT can have, data regarding ICT adoption and integration were also calculated regarding specific clusters of ICT. Specifically, respondents were profiled regarding their available number of ICT within the following type of ICT clusters (Table 9.1.4.1.c). Overall, respondents had on average 14.29 of the total investigated ICT, broken into an average availability of 3.9 critical success ICT and of 11.26 ICT in the hotel property overall (Table 9.1.4.1.d). Specifically, respondents had on average 3 distribution ICT, 4.66 reservation ICT and 4.78 ICT in Rooms Division; however the high negative values of standard deviation, skewness and kurtosis indicated that many respondents had a number of ICT higher than the mean. In FB division, respondents had on average 1.95 ICT, but the high value of standard deviation and negative kurtosis value indicated that few respondents had a number of ICT around the mean. In-room ICT and general ICT accounted for the lowest adoption rates, with respondents having on average 1.93 in-room ICT and 1.75 general ICT. However, the high positive values of standard deviation, skewness and kurtosis for the general ICT indicated that many respondents had a number of general ICT lower than the mean.

Table 9.1.4.1.c Cluster of technologies

Number of distribution technologies (1)	Website online reserv., reservations through e-mail, GDS, Property based, CRS
Number of reservation technologies (2)	Technologies in (1), YM, Customer Database, M&S
Number of in-room technologies (3)	Office facil., TV based services, Voice mail, On demand movies, In-room internet access, Automated mini-bars
Number of ICT in Rooms division only (4)	Front Office system, Telephone system, PBRS, CRS, YM, GDS, M&S, Check in/out kiosks, smart cards
Number of ICT in FB division only (5)	Conf. & Banq. systems, FB systems, Stock & Invent. Systems, EPOS
Number of non FB division ICT (6)	(7) – (5)= (4) + (9)
Number of ICT in whole hotel property (7)	27 technologies
Critical success technologies (8)	PMS, Website, Email, Intranet, Extranet, Customer Database
Number of general ICT (9)	F&A, e-lock, HRM, energy mangmt, MSS, e-procurement, Videoconferencing, DSS
Overall number of ICT	(7) + (8)

Table 9.1.4.1.d Statistics of the distribution of the available number of ICT within each cluster

No. of ICT within clusters:	Min Achieved	Max Achieved	No of ICT within cluster	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
(1)	0	5	5	3	1.215838	-0.29667	0.250029	-0.59438	0.495159
(2)	0	8	8	4.655914	2.061524	-0.42172	0.250029	-0.66375	0.495159
(3)	0	6	6	1.934484	1.509437	0.751293	0.250029	0.253904	0.495159
(4)	0	9	9	4.784946	2.105115	-0.58829	0.250029	-0.2612	0.495159
(5)	0	4	4	1.946237	1.30522	0.131357	0.250029	-1.06982	0.495159
(6)	1	23	23	12.24731	4.964342	-0.24502	0.250029	-0.47441	0.495159
(7)	0	23	28	11.25806	5.220993	-0.10624	0.250029	-0.3306	0.495159
(8)	0.857	6	6	3.890937	1.030889	-0.30351	0.250029	0.089529	0.495159
(9)	0	6	8	1.752688	1.411566	1.139104	0.250029	1.139077	0.495159
(7) + (8)	2	27	33	14.29032	5.839485	-0.21163	0.250029	-0.44991	0.495159

However, because the number of ICT within each cluster is different, average numbers of available ICT in each cluster cannot be used for identifying the cluster accounting for the higher adoption rates. To investigate the latter, for each respondent, the number of available ICT was divided by the maximum number of ICT within each cluster. Statistics of the distribution of these ratios for each ICT cluster were calculated (Table 9.1.4.1.e) and revealed the following adoption patterns across ICT clusters. The cluster of distribution ICT represents the cluster with the highest adoption rates (0.6), followed by the cluster of reservation ICT (0.58), non FB ICT (0.532), rooms division ICT (0.531) and FB ICT (0.487), while far behind are the in-room ICT (0.323) and general ICT (0.219). The low ratios for ICT in the overall hotel property and for total investigated ICT (around 40%) indicate the generally low adoption rates of the total number of the ICT that were being investigated. However, critical success ICT shared a higher adoption ratio than the total number of ICT, (i.e. higher adoption rates of the critical success ICT cluster), which confirms the vitality of the availability of the majority of the critical success ICT.

Table 9.1.4.1.e Statistics of the distribution of the ratio of the number of available ICT to the max potential number of ICT within each cluster

% of ICT within cluster	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
(1)	0	1	0.600	0.243	-0.296	0.250	-0.594	0.495
(2)	0	1	0.581	0.257	-0.421	0.250	-0.663	0.495
(3)	0	1	0.322	0.251	0.751	0.250	0.253	0.495
(4)	0	1	0.531	0.233	-0.588	0.250	-0.261	0.495
(5)	0	1	0.486	0.326	0.131	0.250	-1.069	0.495
(6)	0.043	1	0.532	0.215	-0.245	0.250	-0.474	0.495
(7)	0	0.821	0.402	0.186	-0.106	0.250	-0.330	0.495
(8)	0.142	1	0.648	0.171	-0.303	0.250	0.089	0.495
(9)	0	0.75	0.219	0.176	1.139	0.250	1.139	0.495
(7) + (8)	0.058	0.794	0.420	0.171	-0.211	0.250	-0.449	0.495

For investigating the integration patterns across clusters of ICT, the ratio number of PMS integrated ICT to the total number of ICT within each cluster was calculated for each respondent and then statistics of the distribution of these ratios for each ICT cluster were computed (Table 9.1.4.1.f). Integration rates of ICT clusters are quite low meaning that only nearly half of the available ICT within each cluster are PMS integrated. Overall, respondents were found to have on average 54.55% of their total ICT integrated with their PMS. Integration across clusters showed that generally ICT integration in Rooms division (61.35%) was higher than ICT integration in FB division (47.15%). Specifically, reservation ICT accounted for the highest integration ratio, (50.31%, i.e. on average respondents had nearly half of their reservation ICT integrated with their PMS), integration of FB ICT followed (on average respondents had 47.15% of their distribution ICT PMS integrated), while integration of distribution ICT was considerably well below (44.38%). Despite the low adoption rates of general ICT, the latter had a significant high integration rate (55.65%, i.e. on average respondents with such ICT availability had almost half of their ICT PMS integrated). Thus, when general ICT were found to be available they were as likely to be PMS integrated as the more heavily adopted distribution and reservation ICT. In-room ICT was the cluster with the lowest percentage of PMS integrated ICT (14.64%).

Table 9.1.4.1.f Statistics of the distribution of the ratio of the number of PMS integrated ICT within a cluster to the number of available ICT within the cluster (for hotels with PMS only)

% of PMS integrated ICT within each cluster	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
(1)	0	1	0.443	0.313	0.124	0.272	-0.903	0.538
(2)	0	1	0.503	0.324	-0.215	0.272	-1.117	0.538
(3)	0	1	0.146	0.283	1.935	0.275	2.668	0.544
(4)	0	1	0.613	0.374	-0.132	0.256	-0.656	0.508
(5)	0	1	0.471	0.435	0.116	0.270	-1.707	0.534
(6)	0	0.8	0.402	0.185	-0.436	0.272	-0.020	0.538
(7)	0	1	0.545	0.247	-0.459	0.272	-0.064	0.538
(9)	0	1	0.556	0.428	-0.268	0.270	-1.631	0.534

<u>Direct integration amongst single ICT and integration amongst ICT within the same ICT clusters</u>

Apart from PMS integration data, data regarding integration amongst individual ICT were also gathered. It was expected that the availability of a PMS and so of a systems electronic platform would have eliminated the need of direct systems integration but a t-test revealed that PMS holders and non holders did not significantly differ in their number of direct ICT integrations (significance 0.379 at a significance level of 0.001) (Table 9.1.4.1.g). This is though not surprising since PMS users reported very low integration rates of their ICT with their PMS (from 79% to 0%) and so direct links amongst their ICT were required.

Table 9.1.4.1.g T test results regarding the number of direct integrations between PMS and non PMS holders

PMS	N	Mean	Std. Deviation	Std. Error Mean
yes	78	0.910256	2.319796	0.262665
no	15	1.533333	3.313752	0.855607

										Continued...
	Levene's Test for Equality of Variances			t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
No of integrations amongst ICT	Equal variances assumed	2.727	0.10	-0.885	91.000	0.379	-0.623	0.704	-2.022	0.776
	Equal variances not assumed			-0.696	16.736	0.496	-0.623	0.895	-2.514	1.268

Therefore, because of the low integration levels between PMS and ICT, respondents were expected to report a great number of direct links between individual systems. However, the number of reported direct links was overall very low. Table 9.1.4.1.h illustrates the ICT for which respondents claimed to have a direct link between them; number in cells correspond to number of respondents with an interface, while number in brackets correspond to respondents with a PMS. Generally, direct systems integration is concentrated in three clusters of ICT: a) within distribution and reservation ICT; b) within ICT in FB division; and c) with the Front Office system. Indeed, ICT of the first two clusters did not have any link with any other "external" ICT apart from the Front Office and F&A systems. Front office systems gathered the greatest number of direct links (33).

Table 9.1.4.1.h Direct links amongst ICT (Number of respondents)

	Total no. of direct links	FO	CRS	PBRS	YM	GDS	M&S	Cust Datab.	Telephone	Kiosks	In-room Internet	F&A	Conf & Banq	F&B	EPOS	Stovk & inventory	On-demand movies	e-lock	Voice mail
FO	*35* *(12*		9 (6)	6 (3)	5 (4)	1 (0)	1 (0)	1 (0)	3 (0)	1 (1)		3 (1)	2 (1)		1 (0)		1 (0)	1 (0)	
CRS	*33* *(26*	9 (6)		3 (3)	4 (4)	14 (10	1 (1)	1 (1)				1 (1)							
PBRS	*16* *(13*	6 (3)	3 (3)		2 (2)	2 (2)		1 (1)		1 (1)			1 (1)						
YM	*13* *(12*	5 (4)	4 (4)	2 (2)		1 (1)	1 (1)												
GDS	*18* *(13*	1 (0)	14 (10	2 (2)	1 (1)														
M&S	*3* *(2)*	1 (0)	1 (1)		1 (1)														
Custom. Databas.	*3* *(2)*	1 (0)	1 (1)	1 (1)															
Telephone	*11* *(7)*	3 (0)									2 (2)								6 (5)
Kiosks	*2* *(2)*	1 (1)		1 (1)															
In-room Internet	*2* *(2)*								2 (2)										
F&A	*11* *(8)*	3 (1)	1 (1)										3 (3)	1 (1)	3 (2)				
Conf & Banq	*8* *(7)*	2 (1)		1 (1)								3 (3)		2 (2)					
F&B	*5* *(5)*											1 (1)	2 (2)			2 (2)			
EPOS	*5* *(3)*	1 (0)										3 (2)				1 (1)			
Stock & Invent.	*3* *(3)*													2 (2)	1 (1)				
On-dnd movies	*1* *(0)*	1 (0)																	
e-lock	*1* *(0)*	1 (0)																	
Voice mail	*6* *(5)*								6 (5)										

Amongst all potential direct links, the link between GDS and CRS (which indicates the availability of real time room and rate inventory in GDS) attracted the most respondents (14) highlighting the importance of the provision of online, real time bookings through GDS. When comparing the total number of integrations amongst ICT, the CRS was the most direct integrated ICT (33 links), while YM was the most integrated reservation ICT. Within the cluster of FB ICT, conference and banqueting systems had the greater direct links, followed by EPOS and FB systems and well behind by stock and inventory systems. F&A and Telephone systems also had a considerable number of direct links (11), which is not surprising due to the low-despite their importance- integration levels between them and the PMS (71% and 61% respectively). Actually, the pattern of direct integration amongst ICT was similar with the integration pattern found between PMS and ICT, i.e. distribution ICT gathered the most direct links followed by reservation ICT, then the general ICT namely F&A and then integration within ICT in the Food division are well behind.

Moreover, when comparing the number of direct integrations between PMS holders and non holders it is evident that PMS holders dominantly focused on systems integration within reservation and distribution ICT as well as general and FB ICT, while non PMS holders accounted for the greatest number of integrations between their Front Office and other ICT. Indeed, a t-test revealed that non PMS holders had a significantly greater number of their ICT linked with their FO than PMS holders (Tables 9.1.4.1.i). These findings confirm the fact that because of the piecemeal approach to IT investments PMS holders do not possess a fully integrated PMS solution but are trying to overcome systems integration and compatibility issues by linking systems directly whenever these are purchased. On the other hand, non PMS holders are exploiting their FO system as a systems integration platform.

Table 9.1.4.1.i T test results regarding the number of ICT integrated with FO between PMS holders and non PMS holders

PMS	N	Mean	Std. Deviation	Std. Error Mean
yes	78	0.192	0.684	0.077
no	15	1.266	2.963	0.765

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1.27	Equal variances assumed	28.691	0.000	-2.882	91.000	0.005	-1.074	0.373	-1.815	-0.334
	Equal variances not assumed			-1.397	14.289	0.184	-1.074	0.769	-2.721	0.572

9.1.4.2 Level of sophistication of use of critical success ICT

Descriptive statistics regarding the degree of the sophistication of use of the critical success ICT (i.e. PMS, Website, email, Intranet, Extranet and customer database/warehouse) are also calculated and analysed as follows.

PMS use is mainly focused on automating front and back office operations (96.2% and 88.5% of PMS users claimed to use PMS for such purposes respectively, Table 9.1.4.2.a). A great percentage of respondents also claimed to use PMS to collect and store data (71.8%), but fewer respondents claimed to make use of these data by analysing them and producing reports (65.4%). Only half of the PMS users claimed to use the PMS for providing an electronic platform to their other ICT, which is not surprising when considering the very low integration levels between ICT and PMS. The use of PMS for communication and information sharing purposes accounted for the lowest percentage of respondents (44.9%), indicating the limited use of PMS for allowing flexible working, co-operation between departmental staff and streamline/re-engineering of processes. Thus, for a great percentage of respondents, PMS adoption is only at the first stages of its implementation (automation stage), while only a small proportion of PMS users claimed to have proceed to further stages of ICT implementation. The automation led adoption and use of PMS is not surprising when also considering the generally low levels of IT training provision reported by respondents as well as in several other studies, as IT training is being considered as vital necessity for more sophisticated use of ICT (Sigala et al, 2001b).

Table 9.1.4.2.a PMS use (% of PMS users=78 units)

	N	%
Automate front office operations (1)	75	96.2
Automate back office operations (1)	69	88.5
Communicate and share information between departments (3)	35	44.9
Collect and store data (3)	56	71.8
Analyse data and/or produce reports (5)	51	65.4
Create a platform that supports other applications (5)	39	50.0

Regarding the number of activities for which PMS was used, respondents either claimed to make an average use of PMS systems (19.23% used PMS for 3 features) or a very high PMS use (30.7% used PMS for 6 features), i.e. bimodal distribution of PMS use (Table 9.1.4.2.b).

Table 9.1.4.2.b Distribution of number of uses of PMS

Number of features used	N	Percent	Cumulative Percent
1	4	5.128	5.128
2	11	14.102	19.230
3	15	19.230	38.461
4	11	14.102	52.564
5	13	16.666	69.230
6	24	30.769	100.000
Total	78	100.000	

As concerns the use of the hotel Website (Table 9.1.4.2.c), the provision of hotel information is the main reason of respondents for developing a Website (96.6%), while a considerable percentage of respondents also claimed to use it for communicating with customers (64.8%) and providing links to other sites (63.6%). However, these overall highlight respondents' intention to use the hotel Website for information provision and dissemination. On the contrary, considerably fewer respondents claimed a more sophisticated use of their Website, i.e. 34.1% used it for collecting customer information but only 18.2% used this information for providing customised content and only 30.7% offered the possibility of online bookings. The low percentages of the possibility of online bookings indicate a low level of ICT integration, which though is not surprising considering the overall low reported levels of ICT integration. Overall, it is evident that Website implementation is also found to be at the first stages, i.e. at the information era. Table 9.1.4.2.d illustrates that very low percentages of respondents claimed to use the Website for more than the three most heavily used features, with the 60.22% of respondents using the Website for three purposes.

Table 9.1.4.2.c Website use (% of Website holders=88 hotels)

	N	%
Provide information, e.g. on the hotel property, job vacancies, special offers (1)	85	96.6
Provide links to other sites (1)	56	63.6
Provide real time, online bookings (3)	27	30.7
Communicate with customers (3)	57	64.8
Collect customer information (5)	30	34.1
Provide customised content, e.g. customised deals, access to loyalty program (5)	16	18.2

Table 9.1.4.2.d Distribution of the number of uses of Website

Number of features used	N	Percent	Cumulative Percent
0	2	2.273	2.273
1	14	15.909	18.182
2	16	18.182	36.364
3	21	23.864	60.227
4	19	21.591	81.818
5	11	12.500	94.318
6	5	5.682	100.000
Total	88	100.000	

The greatest majority of respondents (81.3%) claimed to use E-mail for making room reservations and bookings (Table 9.1.4.2.e). This confirms the fact that few hotel websites are able to automate/streamline the booking processes (e.g. through online bookings), while on the other hand e-mail reservation may greatly increase the burden of work to be done. The same is true for e-mail use for external communication and processes, whereby 52.7% of respondents used the e-mail for external communication, but only 29.7% used it for transactional purposes (i.e. computer automated transactions). However, a considerable percentage of respondents (38.5%) claimed to use the e-mail for internal communication.

Table 9.1.4.2.e Email use (% of E-mail users=91 hotels)

	N	%
Make room reservations and bookings (3)	74	81.3
Conduct transactions with suppliers (3)	27	29.7
Enable internal communication and/or co-operation (5)	35	38.5
Enable external communication, e.g. with suppliers (5)	48	52.7

Regarding the number of uses of Email, Table 9.1.4.2.f shows that the greatest majority of respondents use it for one activity, i.e. the most heavily adopted that is making room reservations and bookings. Considerable fewer respondents use the Email for more than one activities.

Table 9.1.4.2.f Distribution of number of uses of Email

Number of features used	N	Percent	Cumulative Percent
0	2	2.197802	2.197
1	39	42.85714	45.054
2	19	20.87912	65.934
3	17	18.68132	84.615
4	14	15.38462	100.000
Total	91	100	

A chi-square test illustrated that the availability of Intranet systems statistically significantly affected the use of e-mail for internal communication, i.e. 24 out of the 35 that used e-mail for Internet communication represented the 80% of Intranet users (Table 9.1.4.2.g). This means that the use of e-mail for internal communication is not attributed to the adoption of the e-mail per se but also to the availability of an Intranet system. Indeed, the major reason for investing on Intranet systems is their capabilities to enable internal communication, re-engineering/streamline of processes and knowledge management, which all presume the communication between departments.

Table 9.1.4.2.g Results of chi-square regarding the use of Email between Intranet and non Intranet users

			Intranet		Total
			no	yes	
E-mail use for internal communication	No	Count	52	6	58
		Expected Count	39.290	18.709	58
		% within Intranet	82.539	20	62.36
		Std. Residual	2.027	-2.938	
	yes	Count	11	24	35
		Expected Count	23.709	11.29032	35
		% within Intranet	17.460	80	37.63
		Std. Residual	-2.610	3.782	
Total		Count	63	30	93
		Expected Count	63	30	93
		% within Intranet	100	100	100

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	33.865	1	5.91E-09		
Continuity Correction	31.253	1	2.26E-08		
Likelihood Ratio	34.801	1	3.65E-09		
Fisher's Exact Test				8.07E-09	8.07E-09
Linear-by-Linear Association	33.501	1	7.12E-09		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.29.

The use of Intranet for information sharing and communications is also confirmed in data in Table 9.1.4.2.h. The greatest majority of respondents claimed to use the Intranet for enabling Internal communication (76.7%) and for storing information (70%). A considerably lower percent (36%) claimed to use the Intranet for making reservations and bookings, which also demonstrates the great use of the communication capability of the system since 23 of the Intranet users claiming to use the Intranet for such activity were owned and managed by an hotel chain while the other 7 were independently managed but were members of a consortia. In this vein, Intranet was used for communication purposes within the chain and consortia enabling the cross marketing of hotel properties. Much lower percentages of respondents claimed to use Intranets for back office or front office automation purposes (20%), as well as for external communication (26.7%) and conduct of transactions (20%). Thus overall, as the focus of Intranet use is concentrated on enabling communications (63% of respondents, Table 9.1.4.2.i used the Intranet for only two activities), the transformational effects and capabilities of Intranet are very limited exploited.

Table 9.1.4.2.h Percentage of hotels using the Intranet for each feature (30 hotels with an Intranet)

	N	%
Automate front office operations (1)	6	20.0
Automate back office operations (1)	6	20.0
Store information, e.g. hotel policies, applications forms (1)	21	70.0
Make room reservations and bookings (3)	11	36.7
Conduct transactions with suppliers (3)	6	20.0
Enable internal communication and/or co-operation (5)	23	76.7
Enable external communication, e.g. with suppliers (5)	8	26.7

Table 9.1.4.2.i Distribution of number of uses of Intranet

Number of features used	N	Percent	Cumulative Percent
0	1	3.333	3.333
1	3	10.000	13.333
2	15	50.000	63.333
3	4	13.333	76.666
4	4	13.333	90.000
6	1	3.333	93.333
7	2	6.666	100.000
Total	30	100.000	

Extranet systems were very limited adopted by respondents (only five) and as Table 9.1.4.2.j illustrates the major purpose of its use is for enabling external communication, which is not surprising considering the nature of such systems, e.g. linking different operators together. However, only one out of the three that used Extranet for external communication also used it for conducting transactions, which again demonstrates the low transformation effects of the systems. Two Extranet users claimed to use it for making reservations and bookings, while none respondent used it for automation purposes and internal communication. Overall, the level of Extranet exploitation was also limited as users used it for one or two activities (Table 9.1.4.2.k).

Table 9.1.4.2.j Extranet use (% of Extranet users=5 hotels)

	N	%
Automate front office operations (1)	0	0.0
Automate back office operations (1)	0	0.0
Store information, e.g. hotel policies, applications forms (1)	0	0.0
Make room reservations and bookings (3)	2	40.0
Conduct transactions with suppliers (3)	1	20.0
Enable internal communication and/or co-operation (5)	0	0.0
Enable external communication, e.g. with suppliers (5)	3	60.0

Table 9.1.4.2.k Distribution of number of uses of Extranet

Number of features used	N	Percent	Cumulative Percent
1	3	60	60
2	2	40	100
Total	5	100	

The use of Customer database is also found to be limited to the first stages of its implementation. Specifically, the greatest majority of respondents claimed to use it for automating front, back (59.7%) and/or marketing staff (61.2%) tasks. Despite the fact that a considerable high percentage of respondents (76.1%) claimed to use it for developing customised promotions and/or products only 22.4% claimed to make full use of the customer data for providing CRM activities (Table 9.1.4.2.l). Moreover, only 29.9% of respondents claimed to use the database in order to plan their hotel strategy. The low level of database use is also illustrated by the fact that almost half of the users (47.7%) use the collected data for a maximum two activities, while the low percentage (44.8%) of respondents that claimed to use the database for enabling staff from different departments to access customer information is not surprising when considering the integration level of the customer database with PMS (only 42% of customer database users had it PMS integrated) (Table 9.1.4.2.m).

Table 9.1.4.2.l Percentage of hotels using the Customer Database for each feature (67 hotels with Database)

	N	%
Automate tasks of front and/or back office staff (1)	40	59.7
Automate tasks of sales and marketing staff (1)	41	61.2
Enable staff of different departments to access customer information (3)	30	44.8
Develop personal customised promotions and/or sales offers (3)	51	76.1
Deliver Customer Relationship Management activities (5)	15	22.4
Plan the hotel strategy (5)	20	29.9

Table 9.1.4.2.m Distribution of number of uses of Customer Database

Number of features used	N	Percent	Cumulative Percent
0	4	5.970	5.970
1	12	17.910	23.880
2	16	23.880	47.761
3	10	14.925	62.686
4	12	17.910	80.597
5	3	4.477	85.074
6	10	14.925	100.000
Total	67	100.000	

In order to compare the level of use across the critical success ICT the following data and analysis is provided. Data in Table 9.1.4.2.n illustrate that the PMS accounts for the ICT that is used for the greatest number of activities, the use of Website and customer database follow, while e-mail, Intranet and Extranet accounted for lower levels of use. However, data based on the number of activities that each ICT is used for are not reliable for cross ICT comparisons because: a) the use of each ICT included a different number of activities; and b) each activity does not carry the same weight of sophistication and so efficiency potential.

Table 9.1.4.2.n Distribution of the number of features used in each critical success ICT

	Min Achieved number	Max Achieved number	Max Potential number	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PMS1	1	6	6	4.153	1.620	-0.312	0.272	-1.196	0.538
WEB1	0	6	6	3.103	1.478	0.105	0.258	-0.768	0.511
ELM1	0	4	4	2.021	1.154	0.487	0.252	-1.057	0.500
INTR1	0	7	7	2.700	1.643	1.368	0.426	1.874	0.832
EXTR1	1	2	7	1.400	0.547	0.608	0.912	-3.333	2.000
DATB1	0	6	6	2.940	1.799	0.333	0.292	-0.883	0.577

To that end, the level of sophistication of use was calculated for each ICT by multiplying the use (1) or not (0) of the activity with its weight. Activities were clustered in three category weights (i.e. score of weights 1, 3, and 5) based on whether they corresponded for automational, informational and transformational/strategic purposes respectively. The average sophistication scores for each ICT are given in Table 9.1.4.2.o.

Table 9.1.4.2.o Distribution of the sophistication scores of critical success ICT users

	N	Min Score achieved	Max Score achieved	Max potential score	Mean	Std. Deviation	Skewness		Kurtosis	
		Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PMS	78	1	18	18	11.102	6.014	-0.261	0.272	-1.327	0.538
Website	88	0	18	18	7.079	5.142	0.485	0.256	-0.800	0.508
E-mail	91	0	16	16	7.890	4.879	0.402	0.252	-1.166	0.500
Intranet	30	0	19	19	7.966	4.597	0.905	0.426	0.864	0.832
Extranet	5	3	8	19	4.800	2.049	1.022	0.912	0.918	2.000
Database	72	0	18	18	7.097	5.622	0.814	0.282	-0.338	0.558

Overall, sophistication scores were found to be considerably low relative to the maximum score that could have been achieved, which demonstrates the fact that hotels are making very limited use of their ICT systems and so, that they are only at the first stages of their ICT implementation. The PMS accounted for the highest sophistication score, which might not be surprising considering the fact that PMS have been adopted by hotels for quite a long time and so hotels are expected to be found on later implementation levels, because of the existence of any experience curves. E-mail users were found to follow in the degree of ICT sophistication of use (mean score 7.8 with maximum potential 16), while Website, Intranet and Customer Databases were found to share similar levels of sophisticated exploitation of their capabilities. Extranets accounted for the lowest sophistication score illustrating that their users did very limited use of their features and capabilities and so, their efficiency potential.

9.2 Measuring productivity

The stepwise approach to DEA was used for measuring productivity in order to:

- Identify the factors contributing to and determining efficiency in our response sample;
- Use these factors in order to construct a robust DEA efficiency model that could effectively measure productivity and discriminate between efficient and inefficient hotels;
- Investigate whether there is any relationship between efficiency scores provided by the robust DEA efficiency model and the ICT metrics; and if any relationship is found
- Identify the specific productivity determinant factors on which ICT have a productivity.

9.2.1 Productivity in the rooms division

9.2.1.1 Construction of the rooms division DEA efficiency model

Determining the DEA input/output factors for Step 1

A stepwise approach to DEA was used in order to construct a robust efficiency model in the rooms division. In the first step aggregate, metrics of inputs and outputs were used, which in turn were divided into their consistent parts when significant correlations were found between the individual input/output metrics and the efficiency scores derived at each step. In step one, the efficiency score (Rooms 1) was calculated using as inputs and outputs the following metrics:

Inputs:
Number of rooms;
Rooms division total payroll and;
Rooms division total non-payroll expenses (material & other)
Output:
Non FB revenue (total hotel revenue minus FB revenue)

Because in DEA inputs and outputs used should satisfy the condition that greater quantities of the selected inputs provide increased output, an isotonicity test was conducted in order to confirm and justify the inclusion of the previous mentioned inputs and outputs in step one. As positive intercorrelations between inputs and output were found (Table 9.2.1.1.a), the isotonicity test is passed and the efficiency scores calculated. Specifically, the DEA model assumed input minimisation and constant returns to scale. Input minimisation was hypothesised meaning that hotels aim to maintain at least the same level of outputs (be effective) while minimising inputs (be efficient). In order to test the validity of the assumption of constant returns to scale, the correlation between efficiency scores and a metric reflecting size of operation should be investigated. To that end, the total number of rooms was used, as this is considered as a good metric directly reflecting the size of operations. As no significant correlations between the number of rooms and rooms efficiency score in all steps were identified, it was concluded that size of operation does not affect rooms efficiency and so, the assumption of constant returns to scale was maintained in the calculation of all the rooms division DEA efficiency models.

Table 9.2.1.1.a Correlations between inputs and output in Rooms 1

		Number of rooms	Total non-payroll expenses	Total payroll expenses	Non-FB revenue
Number of rooms	Pearson Correlation	1	0.647**	0.764**	0.602**
	Sig. (2-tailed)	.	*.000*	*.000*	*.000*
Total non-payroll expenses	Pearson Correlation	0.647**	1	0.661**	0.382**
	Sig. (2-tailed)	*.000*	.	*.000*	*.000*
Total payroll expenses	Pearson Correlation	0.764**	0.661**	1	0.558**
	Sig. (2-tailed)	*.000*	*.000*	.	*.000*
Non-FB revenue	Pearson Correlation	0.602**	0.382**	0.558**	1
	Sig. (2-tailed)	*.000*	*.000*	*.000*	.

** Correlation is significant at the 0.01 level (2-tailed)

Determining the DEA input/output factors for Step 2

In order to identify whether any other specific factor determined efficiency and so, needed to be considered in the DEA efficiency score, the efficiency score at step 1 (Rooms 1) was correlated with all individual input/output factors. Identified significant correlations are highlighted in column Rooms 1 in Tables 9.2.1.1.c and 9.2.1.1.d. The correlations between Rooms 1 and the output metrics namely occupancy, roomnights, ARR, non Room revenue, minor operations revenue and telephone revenue, were stronger than the correlations between Rooms 1 and input variables. Thus, in step 2, the output aggregate metric rather than the input aggregate metrics was broken down into its constituent parts.

Particularly, the non-FB revenue was broken down into the metrics namely ARR, roomnights, and non-room revenue and the process of doing that is analysed as follows. Non-room revenue is the sum of telephone and minor operations revenue, which both correlated with Rooms 1. However, the sum rather than its parts were included in the DEA model in order to avoid having a big number of output factors and so, the need for a greater sample in order to allow the DEA more effectively to discriminate units. However, the fact that the correlations between the efficiency score Rooms 2 and the three variables namely, non-room revenue, telephone revenue and minor operations revenue were not found significant, it meant that the DEA model in step 2 incorporated robust productivity output determinant metrics, as its efficiency score (Rooms 2) was not affected by any of the previously mentioned variables.

Occupancy and roomnights were highly positively correlated, which is expected since occupancy is calculated by dividing roomnights by available roomnights. However, as the DEA methodology does not allow the inclusion of outputs (and/or inputs) that are highly correlated with each other and measure the same factor, only one of these two metrics could had been incorporated into the DEA model. The metric roomnights and not occupancy was used because when the latter was incorporated in the DEA model it obscured and biased the reference sets of hotels. In other words, hotel units were compared with hotels of different size because the DEA identified peers using the occupancy metric which does not reflect hotel size. On the other hand, as the number of roomnights directly reflects the size of operations, it allowed the DEA model to construct an efficiency frontier by comparing hotels of similar size.

Based on these correlations the DEA model was constructed again and the new efficiency score (Rooms 2) was calculated based on the variables illustrated in Table 9.2.1.1.b with an asterisk. The assumptions of input minimization and constant returns to scale (assumption confirmed by no significant correlation between the efficiency score and number of rooms, i.e. a metric of size of operations) were maintained.

Determining the DEA input/output factors for Step 3

In order to check whether the DEA model in step 2 was robust enough and that it incorporated all the variables that determine efficiency in rooms division, the Rooms 2 was again correlated with input and output variables (Table 9.2.1.1.c and 9.2.1.1.d). The strong correlations between the efficiency score and the output metrics identified in step 1 disappeared in step 2 (as well as in the following steps), meaning that: a) the efficiency score is not anymore influenced by the previously identified efficiency determining outputs; and b) the new DEA model significantly discriminates between hotels that are efficient and less efficient as concerns the variables incorporated in the DEA model.

On the other hand, the correlations between Rooms 2 and the inputs factors namely front office payroll (and so, front office expenses) as well as administration non-payroll expenses (and so, administration expenses) increased significantly. The correlations of these factors were stronger than the remaining identified significant correlations and therefore, in the DEA model in step 3, the Rooms division payroll and rooms division non-payroll expenses were broken down in order to reflect these two efficiency determining variables (Table 9.2.1.1.b). The DEA efficiency score, i.e. the Rooms 3, was calculated again based on the input/outputs indicated with an asterisk in Table 9.2.1.1.b under the assumptions of input minimization and constant returns to scale. The latter assumption was confirmed as no significant correlation between the efficiency score and number of rooms, i.e. a metric of size of operations, was found.

In step 1 the efficiency score (Rooms 1) was significantly correlated with the following input/output factors: front office full time staff; minor operations full time staff; marketing full time staff (and so with total hotel full time staff); front office non-payroll; and minor expenses (both payroll and non-payroll minor operations expenses). However, the efficiency score in step 2 (i.e. Rooms 2, which incorporated units that were efficient in the metrics namely roomnights, ARR and non room revenue rather than the aggregate metric non- FB revenue as in Rooms 1) did not significantly correlate with these variables, meaning that these variables did not anymore contribute in the efficiency in the rooms division. That means that in step 2 the DEA efficiency model discriminates between efficient and inefficient hotels on the basis that the former can achieve increased levels in their output metrics (e.g. roomnights, non room revenue), but at the same time they can control for their input expenses (e.g. front office non-payroll expense, minor operations expenses). It is so considered that it is not the input factors that determine efficiency but it is rather the achievement of higher levels of outputs while controlling for the required increased inputs. The stronger correlations between the efficiency scores and the outputs rather than the input factors illustrate this conclusion as well.

Determining the DEA input/output factors for Step 4

The robustness of the DEA efficiency model in step 3 was tested again by correlating Rooms 3 with the input and output factors (Table 9.2.1.1.c and 9.2.1.1.d). All the significant correlations identified in previous models disappeared in step 3, meaning that the effect of these variables on the efficiency score was fully taken into account and that these variables could not anymore be used in order to discriminate between more and/or less efficient units through the DEA technique.

However, Rooms 3 correlated significantly with the metric measuring total variability in business (both weekly and yearly). The correlations between the efficiency score and the business variability metrics were found significant in previous steps as well, but the factor variability was not incorporated into the previous DEA models as the identified correlations were less strong than the correlations with the other variables. Nevertheless, the business variability factor needs to be incorporated into the DEA model when the former is found to affect the efficiency score and so, efficiency in order to consider the effect of environmental variables on productivity. If this is not done, the DEA model would reflect a biased efficiency score because only hotels operating in favorable environmental conditions would be considered as efficient (Avkiran, 1999). On the other hand, as DEA compares like with like, by incorporating the business variability into the DEA model, hotels that are faced with similar market conditions are compared together meaning that hotels that can more effectively manage and/or exploit their given level of business variability by better matching resource levels with business demand are expected to be more efficient.

Business variability is a factor that can negatively influence efficiency because it affects resource utilization, e.g. in periods of low demand hotels are faced with slack resources and non utilized capacity, while in periods of high demand hotels are faced with the decision of coordinating resources for not loosing business potential. However, in Table 9.2.1.1.c the correlation between efficiency score and business variability is illustrated as a positive rather than a negative one. This is explained when the way in which business variability was measured is considered.

Business variability was considered as an environmental factor and particularly as an input in the operations process, but which of course is out of the management's control. Thus, when incorporated into the DEA model, the variability factor has to be considered as an uncontrollable process input. Because the DEA model can only incorporate inputs that positively correlate with outputs, it was concluded that the variability factors should be measured in a way that higher variability scores should lead to greater outputs. However, greater outputs are expected when business variability is low (as it is easier to manage resource levels), which in turn means that the higher variability score should reflect lower business variability. Because of that, weekly and business variability were measured in a scale from 1 to 3 whereby the higher score related to lower variability. In turn, total variability was calculated by multiplying weekly and annual variability reflecting the same concept (i.e. the higher the variability score, the lower the business variability and so greater expected output levels) or in other words a positive correlation between efficiency score and variability score.

The total variability score was included in the DEA model in step 4 and the efficiency score was calculated again, i.e. Rooms 4 under the assumptions of constant returns to scale (assumption confirmed by no significant correlation between the efficiency score and number of rooms, i.e. a metric of size of operations) and output maximisation. Output maximization and not input minimisation had to be assumed because the Rooms 4 DEA model incorporated an uncontrollable input factor (i.e. managers cannot determine business variability but they can control and manage it).

However, DEA gives the same results under both assumptions (input minimization and output maximization) when constant returns to scale are assumed. Thus, the DEA efficiency scores derived from the different steps can be compared with each other, although they were calculated under different goal assumptions, because constant returns to scale were always assumed.

Determination of the most robust rooms division DEA efficiency model

Input and output factors were again correlated with Rooms 4 in order to investigate whether any other factor could now determine and affect the new efficiency score. The significant correlations with the variability score were removed in step 4 meaning that the productivity effect of the variability factor was fully considered. However, the fact that the number of part time employees did not correlate with efficiency scores at step 4 (although it did in previous steps) does not mean that efficient hotels in step 4 are efficient because they better manage part time employees in order to manage business variability. This is because although the correlations between the part time staff and the efficiency score were found to be significant in steps 1 and 2 they were not in step 3 and 4. In other words, the effect of the part time staff on efficiency disappeared before the factor of variability was incorporated into the DEA model. Thus, it cannot be concluded that the number of part time staff was manipulated in order to manage variability and achieve high efficiency levels. Nevertheless, the robustness of the number of part time staff is dubious as it does not directly reflect operational decisions solely in the rooms division but rather in the whole hotel property as well as it does not reflect the actual number of hours worked. Thus, the generations of more reliable conclusions requires the collection of more robust data as well as the investigation on whether any other factors contribute to the efficient management of business variability (e.g. marketing practices).

Since no significant correlations between Rooms 4 and input/output factors were identified (Table 9.2.1.1.c and 9.2.1.1.d), it was concluded that the Rooms 4 DEA efficiency model was the most robust DEA model measuring efficiency in the rooms division. Moreover, the robustness of the DEA models in rooms division was doubled checked by examining the correlations between efficiency scores and two other aggregate productivity metrics namely, hotel profit and non-FB revenue. As significant positive correlations were found (Table 9.2.1.1.d), the robustness of the DEA efficiency models was confirmed.

Table 9.2.1.1.b Input and output metrics included in the stepwise DEA in rooms division

	Rooms 1 (input min)	**Rooms 2** (input min)	**Rooms 3** (input min)	**Rooms 4** (output max)
Outputs				
Non FB total revenue	*			
ARR		*	*	*
Room nights		*	*	*
Non room revenue		*	*	*
Inputs				
Rooms	*	*	*	*
Rooms division total payroll	*	*		
Rooms' division total non-payroll expenses (material & other)	*	*		
Front office payroll			*	*
Administration non payroll expenses (material & other)			*	*
Other rooms' division payroll			*	*
Other rooms' division non payroll (material & other)			*	*
Total demand variability				*

Table 9.2.1.1.c Correlations of Rooms Division efficiency scores with input factors

		Rooms 1	**Rooms 2**	**Rooms 3**	**Rooms 4**
Yearly business variability	Pearson Correlation	0.274803	0.204250	[redacted]	-0.185158
	Sig. (2-tailed)	*0.007681*	*0.049549*	*0.004176*	*0.075593*
Weekly business variability	Pearson Correlation	0.249838	[redacted]	0.241578	-0.201910
	Sig. (2-tailed)	*0.015727*	*0.000370*	*0.019656*	*0.054855*
Total business variability (Yearly * weekly)	Pearson Correlation	[redacted]	[redacted]	[redacted]	-0.203482
	Sig. (2-tailed)	*0.001208*	*0.002764*	*0.003514*	*0.051291*
Property based reservation system (% of reservations)	Pearson Correlation	-0.043691	0.041644	-0.012109	-0.147205
	Sig. (2-tailed)	*0.677525*	*0.691856*	*0.908288*	*0.159107*
Third party (% of reservations)	Pearson Correlation	0.007057	-0.130083	-0.056302	0.179901
	Sig. (2-tailed)	*0.946473*	*0.213942*	*0.591929*	*0.084429*
Internet (% of reservations) (88 units with web)	Pearson Correlation	0.131946	0.269808	0.213074	-0.01946
	Sig. (2-tailed)	0.220414	0.011017	0.046241	0.85719
Number of rooms	Pearson Correlation	0.208638	-0.075363	0.073564	0.208452
	Sig. (2-tailed)	*0.052613*	*0.472776*	*0.483440*	*0.050879*
Length of stay	Pearson Correlation	0.025391	0.086481	0.082941	-0.077876
	Sig. (2-tailed)	*0.809102*	*0.409793*	*0.429296*	*0.458097*
Number of full time employees	Pearson Correlation	[redacted]	0.076550	0.172482	0.204292
	Sig. (2-tailed)	*0.000087*	*0.465812*	*0.098275*	*0.053905*
Number of part time employees	Pearson Correlation	[redacted]	[redacted]	0.289326	0.217738
	Sig. (2-tailed)	*0.000100*	*0.000231*	*0.050115*	*0.051912*
Number of managers	Pearson Correlation	[redacted]	0.162723	0.158210	0.172887
	Sig. (2-tailed)	*0.000979*	*0.119131*	*0.129863*	*0.097476*
Number of IT staff	Pearson Correlation	-0.020240	-0.100695	-0.066954	0.127293
	Sig. (2-tailed)	*0.847300*	*0.336866*	*0.523692*	*0.224016*
Total number of full time staff in rooms division = 1 + 2+ 3+4+5+6	Pearson Correlation	[redacted]	0.058008	0.155738	0.223659
	Sig. (2-tailed)	*0.000276*	*0.580736*	*0.136044*	*0.051154*

Continued ...

Full time front office staff (1)	Pearson Correlation	[redacted]	0.037998	0.098545	0.204842
	Sig. (2-tailed)	*0.003122*	*0.717638*	*0.347336*	*0.050879*
Full time housekeeping staff (2)	Pearson Correlation	[redacted]	0.069129	0.161230	0.136268
	Sig. (2-tailed)	*0.000158*	*0.510262*	*0.122605*	*0.192770*
Full time telephone staff (3)	Pearson Correlation	0.075965	-0.168180	-0.010676	0.150160
	Sig. (2-tailed)	*0.469238*	*0.107085*	*0.919103*	*0.150814*
Full time administration staff (4)	Pearson Correlation	0.169458	-0.044446	0.088019	0.202391
	Sig. (2-tailed)	*0.104407*	*0.672269*	*0.401482*	*0.054659*
Full time marketing staff (5)	Pearson Correlation	[redacted]	0.213385	0.199581	0.201249
	Sig. (2-tailed)	*0.000077*	*0.040005*	*0.055110*	*0.053068*
Full time minor operations staff (6)	Pearson Correlation	[redacted]	0.234591	0.239135	0.249297
	Sig. (2-tailed)	*0.000015*	*0.051730*	*0.020968*	*0.055961*
Proportion of total hotel payroll paid for full time staff	Pearson Correlation	-0.058983	-0.190006	-0.212156	-0.163601
	Sig. (2-tailed)	*0.574383*	*0.068118*	*0.041193*	*0.117127*
Adm. non payroll expenses / adm. expenses	Pearson Correlation	[redacted]	[redacted]	-0.229384	-0.220084
	Sig. (2-tailed)	*0.000059*	*0.000000*	*0.058271*	*0.052229*
Front office payroll / rooms division payroll	Pearson Correlation	[redacted]	[redacted]	-0.206968	-0.206247
	Sig. (2-tailed)	*0.000000*	*0.000000*	*0.053271*	*0.052271*
Front office expenses = 7 + 8	Pearson Correlation	[redacted]	[redacted]	-0.225862	0.108144
	Sig. (2-tailed)	*0.045147*	*0.000003*	*0.054368*	*0.307555*
Front office non-payroll expenses (material & other) (7)	Pearson Correlation	[redacted]	0.044686	0.228229	0.241800
	Sig. (2-tailed)	*0.001307*	*0.674052*	*0.029565*	*0.050913*
Front office payroll expenses (8)	Pearson Correlation	[redacted]	[redacted]	-0.689798	-0.241365
	Sig. (2-tailed)	*0.000102*	*0.000000*	*0.000000*	*0.019768*
Housekeeping expenses = 9 + 10	Pearson Correlation	0.170913	-0.057046	-0.039132	0.076299
	Sig. (2-tailed)	*0.101420*	*0.587037*	*0.709587*	*0.467279*
Housekeeping non-payroll expenses (material & other) (9)	Pearson Correlation	0.176007	-0.019538	0.025374	0.127467
	Sig. (2-tailed)	*0.091489*	*0.852534*	*0.809226*	*0.223378*
Housekeeping payroll (10)	Pearson Correlation	0.146425	-0.074777	-0.076913	0.033064
	Sig. (2-tailed)	*0.161354*	*0.476237*	*0.463695*	*0.753039*
Telephone expenses = 11 + 12	Pearson Correlation	0.054179	-0.024599	0.011743	0.125462
	Sig. (2-tailed)	*0.605999*	*0.814946*	*0.911046*	*0.230805*
Telephone non-payroll expenses (material & other) (11)	Pearson Correlation	0.162933	0.036171	0.062593	0.127908
	Sig. (2-tailed)	*0.118650*	*0.730681*	*0.551142*	*0.221768*
Telephone payroll (12)	Pearson Correlation	-0.024876	-0.054200	-0.021611	0.090687
	Sig. (2-tailed)	*0.812899*	*0.605857*	*0.837090*	*0.387311*
Minor operations expenses = 13 + 14	Pearson Correlation	[redacted]	0.200418	0.234572	0.200249
	Sig. (2-tailed)	*0.000031*	*0.053435*	*0.053623*	*0.054285*
Minor operations non-payroll expenses (material & other) (13)	Pearson Correlation	[redacted]	0.209346	0.226636	0.207191
	Sig. (2-tailed)	*0.000108*	*0.054907*	*0.058922*	*0.051290*
Minor operations payroll (14)	Pearson Correlation	[redacted]	0.204326	0.213360	0.165908
	Sig. (2-tailed)	*0.000088*	*0.057791*	*0.050029*	*0.111980*
Administration expenses = 15 + 16	Pearson Correlation	-0.191932	[redacted]	-0.236166	-0.015840
	Sig. (2-tailed)	*0.065319*	*0.000000*	*0.050012*	*0.880210*
Administration non-payroll expenses (material & other) (15)	Pearson Correlation	[redacted]	[redacted]	-0.198622	-0.068074
	Sig. (2-tailed)	*0.005802*	*0.000000*	*0.051212*	*0.516752*

Continued...

Administration payroll (16)	Pearson Correlation	0.169157	-0.043664	0.051163	0.115317
	Sig. (2-tailed)	*0.105032*	*0.677712*	*0.626226*	*0.271023*
Marketing expenses = 17 + 18	Pearson Correlation	0.188696	0.001250	0.031235	0.050730
	Sig. (2-tailed)	*0.073246*	*0.990620*	*0.768822*	*0.632971*
Marketing non-payroll expenses (material & other) (17)	Pearson Correlation	0.247383	-0.129512	-0.003647	0.209248
	Sig. (2-tailed)	*0.018072*	*0.221123*	*0.972627*	*0.046525*
Marketing payroll (18)	Pearson Correlation	0.088987	0.064553	0.035712	-0.061000
	Sig. (2-tailed)	*0.396308*	*0.538719*	*0.733975*	*0.561345*
Total IT training expenses	Pearson Correlation	0.149090	0.055698	0.017263	0.063717
	Sig. (2-tailed)	*0.153779*	*0.595921*	*0.869542*	*0.544004*

[redacted] Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 9.2.1.1.d Correlations of Rooms Division efficiency scores with output factors

		Rooms 1	**Rooms 2**	**Rooms 3**	**Rooms 4**
Repeat customers (% of roomnights)	Pearson Correlation	-0.088930	0.055512	0.112000	-0.003340
	Sig. (2-tailed)	*0.396607*	*0.597148*	*0.285136*	*0.974656*
Business travellers (% of roomnights)	Pearson Correlation	0.147510	0.071202	0.125984	0.206606
	Sig. (2-tailed)	*0.158236*	*0.497633*	*0.228856*	*0.046925*
Leisure travellers (% of roomnights)	Pearson Correlation	-0.208671	-0.061119	-0.158364	-0.199421
	Sig. (2-tailed)	*0.044718*	*0.560579*	*0.129484*	*0.055311*
Conference travellers (% of roomnights)	Pearson Correlation	0.135926	-0.056691	0.033060	0.018448
	Sig. (2-tailed)	*0.193899*	*0.589374*	*0.753072*	*0.860672*
Occupancy	Pearson Correlation	[redacted]	0.248511	0.252257	0.017557
	Sig. (2-tailed)	*0.001781*	*0.053656*	*0.054713*	*0.867345*
Average Room Rate (ARR)	Pearson Correlation	[redacted]	0.229220	0.214475	0.190290
	Sig. (2-tailed)	*0.000000*	*0.051272*	*0.052141*	*0.067699*
Roominghts	Pearson Correlation	[redacted]	0.087039	0.202592	0.209205
	Sig. (2-tailed)	*0.000407*	*0.406766*	*0.051469*	*0.051723*
Non FB revenue = Total Revenue – FB revenue = Rooms revenue + 1 + 2	Pearson Correlation	[redacted]	[redacted]	[redacted]	[redacted]
	Sig. (2-tailed)	*0.000000*	*0.000065*	*0.000144*	*0.000053*
Hotel profit	Pearson Correlation	[redacted]	[redacted]	[redacted]	[redacted]
	Sig. (2-tailed)	*0.000000*	*0.001932*	*0.000428*	*0.000256*
Rooms revenue	Pearson Correlation	[redacted]	-0.128336	-0.032741	0.081103
	Sig. (2-tailed)	*0.027790*	*0.220210*	*0.755380*	*0.439624*
Non room revenue = (1) +(2)	Pearson Correlation	[redacted]	0.201881	0.194152	0.206564
	Sig. (2-tailed)	[redacted]	*0.050065*	*0.050144*	*0.050053*
Revenue from minor operations (1)	Pearson Correlation	[redacted]	0.220647	0.211150	0.202504
	Sig. (2-tailed)	*0.000000*	*0.050027*	*0.050106*	*0.050063*
Revenue fro m telephone operations (2)	Pearson Correlation	[redacted]	0.080103	0.151030	0.237871
	Sig. (2-tailed)	*0.000006*	*0.445303*	*0.148435*	*0.051677*

[redacted] Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

9.2.1.2 Factors that determine efficiency in rooms division

By applying the stepwise approach to DEA, input/outputs that determine efficiency in rooms division based on the data gathered from the sample respondents were identified. Analytically, the outputs/inputs that determine the efficiency frontier in rooms division were found to be: ARR; roomnights; non room revenue; front office payroll; other payroll; administration non-payroll expenses; other non payroll expenses; and the external factor of business variability. In particular, it was found that hotels that achieved high levels of ARR, roomnights and non-room revenue with minimum inputs, and specially those that efficiently managed front office payroll and administration non-payroll expenses, while controlling for fluctuations in business were found to be efficient.

In order to demonstrate more effectively how these factors determine the efficiency frontier in rooms division, the following statistics were calculated (Table 9.2.1.2.a) from which radar plot type of figures (Figures 9.2.1.2.a, 9.2.1.2.b, 9.2.1.2.c and 9.2.1.2.d) were constructed. Particularly, statistics regarding the configuration of the input/output factors that were found to determine efficiency based on the robust DEA model were calculated and compared for three efficiency categories of hotels: 1) the rooms division efficient units; 2) the rooms division inefficient units with an inefficient score above the median inefficiency score and; 3) the rooms division inefficient units with an inefficiency score lower than the median inefficiency score. Moreover, the configuration of the inputs/outputs for each category was calculated based on the efficiency scores found at all steps in order to illustrate the robustness of the DEA model in step 4, i.e. its ability to distinguish and build different efficiency frontiers for efficient and inefficient units. The process and rationale of these calculations as well as findings are analysed as follows.

For clustering hotels based on their efficiency score, the median rather than the average inefficiency score was chosen, because as the distribution of the efficiency scores in the sample did not follow a normal distribution, (there were no units with very low inefficiency scores, e.g. below 30%), the average score would have been inflated by and biased towards the efficiency score of the very efficient units. Having clustered the hotels, the average scores of the inputs/outputs for each category were calculated. However, for comparing the input/output configuration between the inefficient and efficient units, instead of using the raw average scores of inputs and outputs for each category, percentage ratios of the average scores of the inefficient units (categories 2 and 3) to the average scores of the efficient units (category 1) were calculated and used. This was because efficiency categories were consisted of different number of hotels as well as because inputs and outputs were measured in different units. Moreover, regarding the latter, the use of percentages also allowed: a) easier illustration since all inputs/outputs could be incorporated in a radar plot with the same scale of measurement in all its dimensions (i.e. inputs/outputs); and b) more reliable comparisons between inputs and outputs as they were all now measured with the same percentage scale.

Table 9.2.1.2.a Average and percentages scores of inputs/outputs per efficiency category

		Rooms 1	Rooms 2	Rooms 3	Rooms 4	1%	2%	3%	4%
Efficient units	TOT.VAR	5	4.083333	4.4375	2.909091	1	1	1	1
	ROOMS	88.2	70.66667	75.4375	107.303	1	1	1	1
	ARR	116.4	74.18	69.18313	64.80364	1	1	1	1
	ROOMNIGHTS	23484.3	20479.75	22750.69	28760.52	1	1	1	1
	NONROOM£	650102.1	473354.9	402482.3	379005.9	1	1	1	1
	FRON.PAY	37875.0	36559.83	43294.88	96134.18	1	1	1	1
	ADM£M.O	2000.0	2250	8096.875	92559.97	1	1	1	1
	room pay minus front pay	342057.0	255102.3	286214.3	312605.8	1	1	1	1
	room expenses not adm mat and oth	234208.0	191179.3	193726.9	254717.7	1	1	1	1
inefficient units with inefficiency score above the median inefficiency score	TOT.VAR	3.822222	3.761905	3.552632	3.62069	0.764	0.921	0.801	1.245
	ROOMS	112.2667	98.59524	107.9737	100.1034	1.272	1.395	1.431	0.933
	ARR	62.19022	61.46905	61.76368	56.35517	0.534	0.829	0.893	0.87
	ROOMNIGHTS	30288.04	27999.76	29367.74	24967.83	1.29	1.367	1.291	0.868
	NONROOM£	345748	290973.4	304816.9	265789.8	0.532	0.615	0.757	0.701
	FRON.PAY	112251.7	77034.71	93687.5	140326.6	2.964	2.107	2.164	1.46
	ADM£M.O	92897.56	40906.98	63578.55	177697.2	46.449	18.181	7.852	1.92
	room pay minus front pay	375753.8	369398.6	375209.6	373208	1.099	1.448	1.311	1.194
	room expenses not adm mat and oth	275226.4	234393.5	259158.5	258274.5	1.175	1.226	1.338	1.014
inefficient units with inefficiency score below the median inefficiency score	TOT.VAR	2.840909	2.820513	2.846154	3.741935	0.568	0.691	0.641	1.286
	ROOMS	68.27273	87.69231	79.46154	63.3871	0.774	1.241	1.053	0.591
	ARR	49.55182	50.5759	51.03513	53.91935	0.426	0.682	0.738	0.832
	ROOMNIGHTS	16147.86	19119.44	17626.15	15943.26	0.688	0.934	0.775	0.554
	NONROOM£	98191.28	117393.4	114275	73044.6	0.151	0.248	0.284	0.193
	FRON.PAY	144966.1	202747.6	187910	139981.8	3.827	5.546	4.34	1.456
	ADM£M.O	171138.3	255727.7	235203.6	113250.9	85.569	113.65	29.049	1.224
	room pay minus front pay	260581.1	286326.9	279623.7	277538.5	0.762	1.122	0.977	0.888
	room expenses not adm mat and oth	138299.5	183422.8	163510.9	116484.5	0.59	0.959	0.844	0.457

Productivity comparisons in steps 2 and 3

As results in Table 9.2.1.2.a and their illustration in the below figures illustrate, although the inefficient units with an inefficient score below the median inefficient score have a greater room capacity than the efficient units (124% and 105.3% more rooms than the efficient) they achieve only the 93% and 77.5% of the roomnights, the 24% and 28% of the non-room revenue and the 68% and 73% of the ARR that the efficient units achieve while also spending proportionally more resources than their bigger size might require. Particularly, although they are of 124% and 105.3% of greater room capacity than the efficient units, their front office expenses are 554% and 434% greater than the efficient units while their administration non-payroll expenses are 11,365% and 2,904% greater than those of the efficient units. However, as the variability score in steps 2 and 3 indicates, inefficient units with an inefficient score below the median inefficient score are faced with a lower business variability score and so greater business fluctuations than efficient units, meaning that for some units their inefficiency can be due to great business fluctuations.

Relative to the efficient units, the inefficient units with an inefficiency score above the median inefficient score are doing better than the inefficient units below the media score units (i.e. they have a closer input/output configuration to that of the efficient units). However, the former although they are of a greater room capacity than the efficient units (127%, 139% and 143% more rooms than the efficient unit in steps 1, 2 and 3 respectively), they do not achieve the same proportional level in roomnights (i.e. they achieve only 129%, 136% and 129% more roomnights than efficient units in steps 1, 2, and 3, meaning that in steps 2 and 3 the inefficient units achieve 3% and 14% less roomnights from that which they would be expected because of their greater room capacity). So, although inefficient units above the median achieve greater percentages as concerns ARR and non-room revenue than the inefficient units below the median, these are still quite below of those of the efficient units. In particular, inefficient units above the median achieve only the 53%, 82% and 89% of the ARR as well as the 53%, 61% and 75% of the non-room revenue that the efficient units achieve in steps 1, 2 and 3 respectively. As concerns, front office payroll and administration non-payroll expenses inefficient units above the median are better controlling their expenses relative to inefficient below the median but still not as good as efficient units. Analytically, inefficient units above the median although being 127%, 139% and 143% of greater room capacity than efficient units they overspend proportionally more front-office payroll and administration non-payroll expenses than efficient units, (i.e. 296%, 210% and 216% front office payroll and 4,644%, 1,818% and 785% administration non payroll expenses in steps 1, 2 and 3 respectively). However, inefficient units are faced with higher business variability score and so fewer business fluctuations than efficient units, meaning that the efficiency score of some units might be inflated by the favourable conditions that they face.

Productivity comparisons in step 4

Because the variability score was found to significantly correlate with the efficiency score meaning that it affected efficiency, business variability was incorporated in step 4 as an uncontrollable input in order to account for inefficiencies that are due to business variability as well as to allow units that can more effectively control their inputs/outputs relative to their peers facing the same degree of business variability to become efficient or increase their efficiency score. Indeed, in step 4, as Table 9.2.1.2.a illustrates, the variability score of the inefficient units is greater (i.e. the fluctuations in business are less) than that of the efficient units, meaning that the inefficiency of the inefficient units cannot anymore be contributed to business variability. This is because in step 4 inefficient units that could effectively manage the great business variability were allowed to become efficient.

The inefficient units below the media although of a smaller room capacity than the efficient units (59% of the rooms of the efficient units) they only achieve the 55% of the roomnights of the efficient units, meaning that they achieve 4% less roomnights than would be expected due to their smaller room capacity. The former also achieve only the 83% of the ARR and the 19% of the non-room revenue of the efficient units and despite their smaller size they spend 1,456% and 1,224% of the front office payroll and administration non-payroll expenses of the efficient units. The overspend in resources (relative to hotel size) is less as concerns other payroll and other non-payroll expenses than the previous expenses (i.e. 88% and 45% of those of the efficient units respectively), which illustrates the fact that it is the former expenses rather than other payroll and other non-payroll expenses that significantly determine efficiency. So, as for inefficient units, front office payroll and administration non-payroll expenses are more than would have been expected because of their smaller size and the proportionally fewer roomnights relative to the efficient units, their inefficiency is mainly attributed to these two former factors.

Relative to the efficient units, inefficient units above the median are doing better than the inefficient units below the median in terms of ARR and non-room revenue (i.e. the former achieve 87% of the ARR and 70% of the non-room revenue of the efficient units). The same can be said in terms of expenses management. So, the inefficient above the median have similar overspends in terms of front-office payroll, administration non-payroll expenses, other payroll and other expenses as inefficient units below the median. However, as the former are of a greater room capacity than the latter, this overspend can be more justifiable. However, when comparing the inefficient above the median with the efficient units, it is evident that although the former have the 93% of the efficient units room capacity they achieve proportionally fewer roomnights, (i.e. 86% of the efficient units roomnights meaning 7% fewer roomnights than expected). Moreover, although efficient units are of a smaller size of inefficient units, the latter achieve less ARR and non-room revenue than the efficient units (the 87% and 70% respectively). Overall, the inefficiency of inefficient units with an inefficient score above the median can be attributed to both underachievement of output metrics and overspend of input metrics.

These findings are mapped into radar plot diagrams in the figures below. As we migrate from models 1, 2, and 3 to the robust DEA productivity model the productivity determinant factors construct an efficiency frontier for the efficient hotels that is more clearly different, distinct and better from that of the inefficient units. In particular, it is evident that in steps 1, 2 and 3 it was the overspent in front-office payroll and the administration non-payroll expenses that significantly contributed to the great inefficiencies (Figures 9.2.1.2.a, 9.2.1.2.b and 9.2.1.2.c). In step 4, the business variability was incorporated in the DEA model in order to take into account the inefficiencies that are due to fluctuations in business. So, as inefficient units had a higher variability score, i.e. fewer fluctuations in business, this meant that their inefficiencies cannot anymore attributed to business fluctuations. In Figure 9.2.1.2.d, it is evident that the efficient units outperform inefficient units in terms of ARR, non-room revenue and roomnights taking into account their greater room capacity. At the same time, efficient units can manage their high levels of outputs with fewer expenses than inefficient units. Specifically, efficient units significantly outperform in terms of controlling their front office payroll and administration non-payroll expenses, while in terms of the other expenses they are doing much better than the smaller in size inefficient units below the media but less better than the slightly smaller inefficient units above the media.

Figure 9.2.1.2.a Configuration of productivity determinant inputs/outputs in Rooms 1 DEA efficiency model

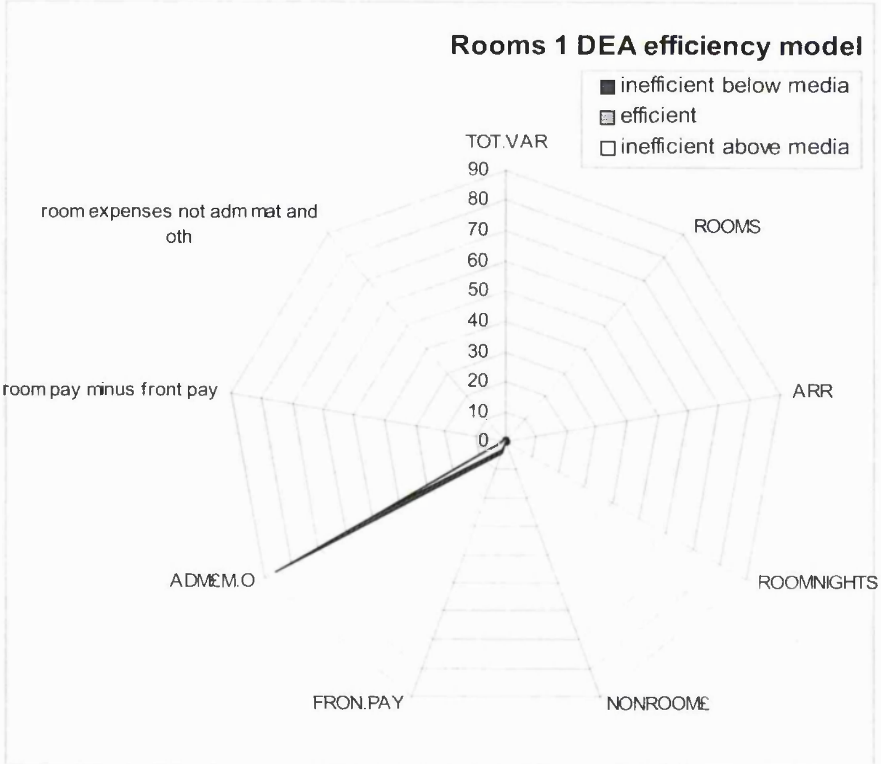


Figure 9.2.1.2.b Configuration of productivity determinant inputs/outputs in Rooms 2 DEA efficiency model

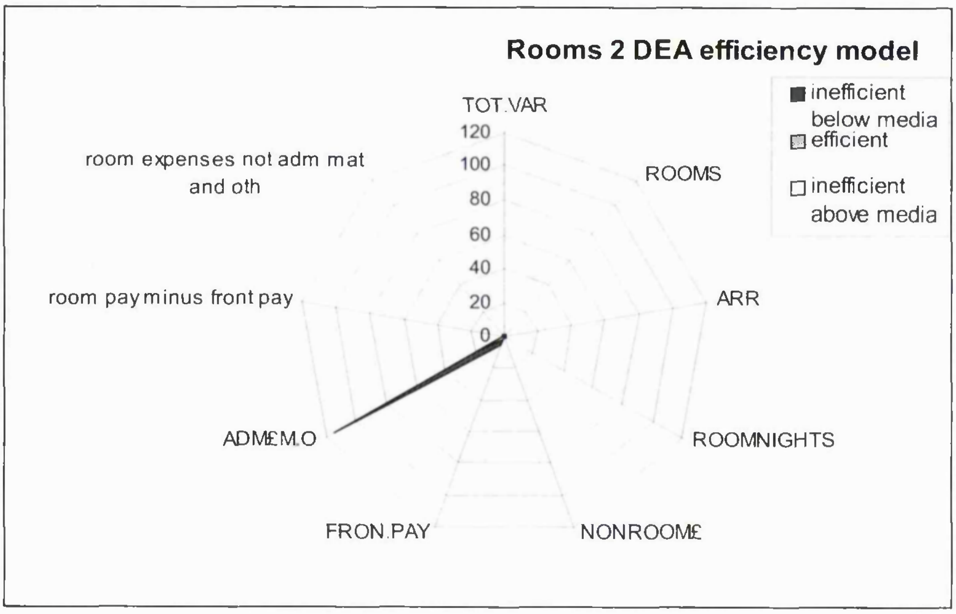


Figure 9.2.1.2.c Configuration of productivity determinant inputs/outputs in Rooms 3 DEA efficiency model

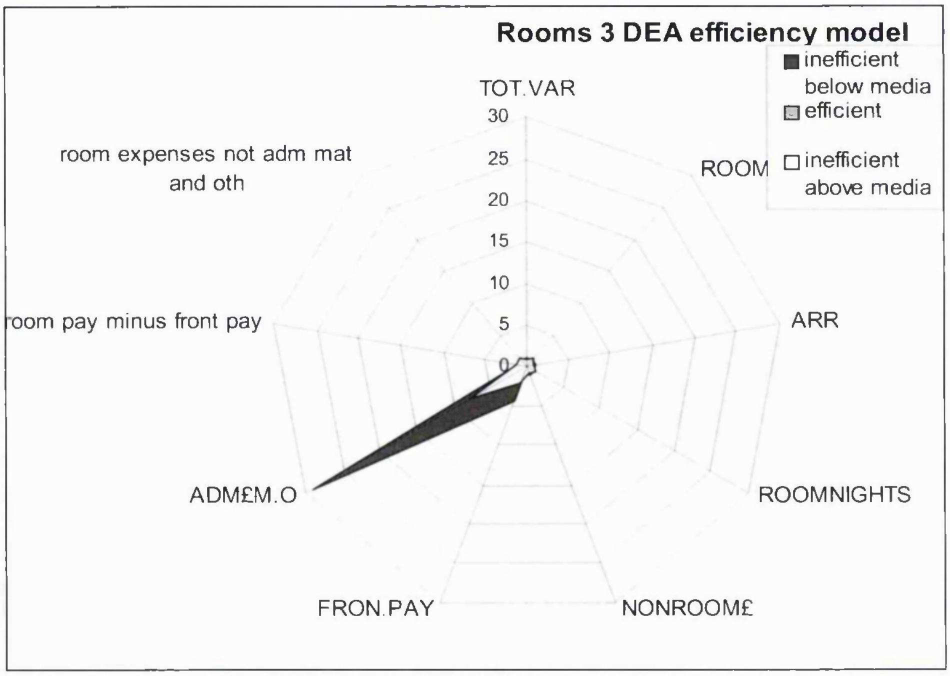
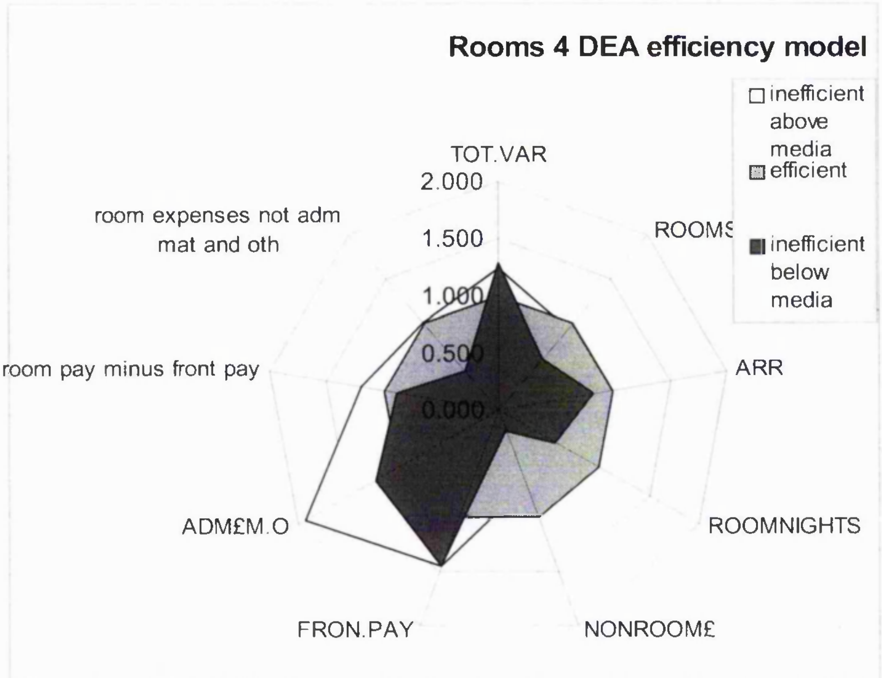


Figure 9.2.1.2.d Configuration of productivity determinant inputs/outputs in Rooms 4 DEA efficiency model



Apart from the factors that were found to affect efficiency, some other factors that were expected to do so they did not. Particularly, the following factors did not significantly correlate with DEA efficiency scores (Tables 9.2.1.1.c and 9.2.1.1.d) and so, they were not found to affect productivity: type of distribution channel used for reservations (property based system, Internet, third party); length of stay; number of full time employees; number of pert time employees; number of managers and/or head of departments; number of IT staff; total number of full time staff in rooms division; full time front office staff; full time housekeeping staff; full time administration staff; full time marketing staff; full time minor operations staff; proportion of total hotel payroll paid for full time staff; front office material and other expenses; housekeeping payroll; housekeeping material and other expenses; telephone expenses; telephone material and other expenses; minor operations payroll; minor operations material and other expenses; administration payroll; marketing payroll; marketing material and other expenses; expenses on IT training; percentage of roomnights from repeat customers; percentage of roomnights per market segment (business, leisure, conference).

9.2.1.3 Distinguishing between market and operational efficiency in rooms division

A market factor namely business variability was found to affect productivity and so included into productivity benchmarking. However, depending on whether business variability is included in DEA models or not, the latter reflect either operational efficiency or market efficiency. Operational efficiency is considered as the efficiency of an operating system irrespective of the environmental/market factors that can influence the smoothness and flow of its operations and so its efficiency, while market efficiency is considered as the ability to efficiently manage market conditions. Specifically, as the DEA efficiency models in step 1, step 2 and step 3 do not incorporate the business variability factor it can be concluded that Rooms 1, Rooms 2 and Rooms 3 efficiency scores measure and reflect the operational efficiency in rooms division, with Rooms 3 DEA efficiency model being the most robust operational efficiency model. On the other hand, Rooms 4 DEA efficiency model incorporated a market factor, i.e. business variability, and so it is argued that Rooms 4 is a combined DEA efficiency model measuring both market and operational efficiency. This means that Rooms 4 identifies and distinguishes hotels as efficient when they can effectively manage and control their operations given the market conditions they face.

Table 9.2.1.3.a below illustrates the raw efficiency scores for all hotels in both steps 3 and 4. As a significant correlation between variability and efficiency score was found in step 3, business variability was found to be a determinant of efficiency and so included in step 4. The fact that business variability was responsible for some of the inefficiency of units in step 3 is also evident from the fact that the efficiency score of most hotels increased from 3 and 4. However, because step 4 reflects both operational and market efficiency, further analysis was undertaken in order to distinguish hotels that were market efficient only from operational efficient hotels. The reasons for distinguishing between market and operational efficiency are twofold: a) to further explore and identify the reason(s) for which hotels are efficient or inefficient and so suggest appropriate productivity improvement strategies; and b) to more precisely measure productivity in order to make more reliable assessments as concerns the impact of ICT on productivity, as different types and uses of ICT may or may not

impact certain productivity types. The process for distinguishing market from operational efficiency is analysed as follows.

Table 9.2.1.3 Efficiency scores in rooms divisions in steps 3 and 4

Hotel unit	Room 3	Room 4	Hotel unit	Room 3	Room 4	Hotel unit	Room 3	Room 4
1	61.54	61.54	**32**	64.29	70.6	**63**	100	100
2	87.37	87.37	**33**	73.84	73.84	**64**	70.58	70.72
3	63.77	63.77	**34**	53.54	69.59	**65**	53.95	53.95
4	100	100	**35**	54.42	83.22	**66**	80.06	95.41
5	35.16	85.11	**36**	75.25	75.25	**67**	50.06	50.06
6	58.96	58.96	**37**	60.6	100	**68**	100	100
7	67.19	67.19	**38**	49.13	74.63	**69**	87.2	87.2
8	37.91	44.97	**39**	90.59	90.59	**70**	89.35	89.35
9	100	100	**40**	100	100	**71**	54.08	72.08
10	100	100	**41**	57.01	57.01	**72**	44.53	100
11	47.57	50.92	**42**	53.14	100	**73**	66.7	70.32
12	66.38	66.38	**43**	100	100	**74**	63.19	63.19
13	65.33	65.33	**44**	92.87	92.87	**75**	74.11	74.11
14	40.73	40.73	**45**	99.94	100	**76**	100	100
15	55.39	55.39	**46**	67.91	100	**77**	100	100
16	40.86	95.05	**47**	51.39	51.39	**78**	68.82	72.9
17	61.34	93.02	**48**	64.88	65.25	**79**	85.1	97.34
18	100	100	**49**	60.79	100	**80**	98.58	100
19	86.53	100	**50**	57.92	62.17	**81**	66.24	71.79
20	51.23	100	**51**	53.01	53.01	**82**	62.22	65.62
21	100	100	**52**	60.67	66.04	**83**	100	97.28
22	86.54	100	**53**	58.06	58.06	**84**	79.31	81.69
23	100	100	**54**	54.07	69.82	**85**	75.33	100
24	100	100	**55**	85.86	100	**86**	62.9	74.9
25	87.39	100	**56**	82.82	82.82	**87**	81.43	96.87
26	91.93	91.93	**57**	68.39	85.9	**88**	74.21	80.66
27	82.14	100	**58**	72.67	72.67	**89**	71.6	100
28	67.76	100	**59**	44.66	62.06	**90**	82.28	90.9
29	100	87.06	**60**	39.49	90.33	**91**	88.36	100
30	65.95	100	**61**	55.21	55.21	**92**	72.95	74.62
31	94.56	94.56	**62**	100	100	**93**	85.42	100

Hotels were classified into a two dimensional matrix (Table 9.2.1.3.b) depending on whether they are efficient or inefficient in Rooms 3 (operational efficiency only) as well as in Rooms 4 (both operational and market efficiency). So, hotels in cluster 3 are efficient in the combined model but inefficient in the operations efficiency model, meaning that they are market efficient only because they become efficient only when the market conditions are considered. As hotels in cluster 3 have the lowest variability score than hotels in other clusters, this means that they were actually allowed to become efficient because they can more effectively manage the high fluctuations in business they and their peers face and so, achieve greater input/output levels.

On the other hand, the two hotels in cluster 2 are efficient in the operations model but inefficient in the combined model. In other words, hotels in cluster 2 are operational efficient only, meaning that they run an efficient system but when the market conditions are considered they become inefficient because their peers can achieve better input/output levels given the circumstances.

Hotels that are efficient under both the operational and combined model, which means that they are both operational and market efficient, are placed in cluster 4. In other words, these hotels are doing well both in running an efficient operating system as well as managing the latter under the market conditions within which they are. The fact that hotels in cluster 4 have the highest average variability score that also concentrates on the "somewhat" variability value may indicates that the operational and market efficiency of these hotels may be due to the fact that they are faced with stable/medium business volumes, i.e. they do not face neither very high nor not at all business fluctuations.

Hotels in cluster 1, i.e. inefficient hotels in both models, are inefficient both when benchmarking their operational system per se as well as when considering for inefficiencies that can be due to their market conditions. In other words, these hotels are both operational and market inefficient.

Table 9.2.1.3.b Operational-Market efficiency matrix in rooms division

Market efficiency		Operational efficiency: Inefficient (In Room 3)	Operational efficiency: Efficient (In Room 3)
	Efficient (In Room 4)	**Cluster 3** *Units:* 19 *Variability score:* Min=1 Max= 4 Aver.=1.7	**Cluster 4** *Units:* 14 *Variability score:* Min=1 Max= 6 Aver.=4.5
	Inefficient (In Room 4)	**Cluster 1** *Units:* 58 *Variability score:* *Min=1 Max= 9 Aver.=3.6*	**Cluster 2** *Units:* 2 *Variability score:* *Min=2 Max= 6 Aver.=4*

Hotels in cluster 3 need to improve their operational efficiency, i.e. improve their operating system, hotels in cluster 2 need to better manage their operating system in light of the market conditions while hotels in cluster 1 can improve their productivity by configuring a more efficient operating system as well as by controlling (managing or exploiting) the effect of market conditions on the former.

9.2.2 Productivity in the FB division

9.2.2.1 Construction of the FB DEA efficiency model

Determining the DEA input/output factors for Step 1

A stepwise approach was also used for the construction of the DEA efficiency model in FB. Thus, aggregate metrics of inputs and outputs were used at the first step, which could then be analysed in their constituent parts if the latter correlated with the efficiency score. At the first step, a DEA efficiency score was calculated (FB1) incorporating three inputs namely FB payroll, non-payroll (i.e. material and other) FB expenses and total FB capacity and FB revenue as an output. For confirming the inclusions of these variables into the DEA model an isotonicity test was conducted. The positive intercorrelations between the three inputs and the output justified the inclusion of these variables in the model (Table 9.2.2.1.a).

Table 9.2.2.1.a Inter-correlations between inputs and outputs

		FB capacity	F.B. Payroll	Non-Payroll FB expenses	FB revenue
FB capacity	Pearson Correlation	1	0.674**	0.604**	0.607
	Sig. (2-tailed)	.	*1.32527E-13*	*1.406E-10*	*1.169E-10*
F.B. **Payroll**	Pearson Correlation	0.674**	1	0.705**	0.938**
	Sig. (2-tailed)	*1.33E-13*	.	*3.247E-15*	*1.653E-43*
Non-Payroll FB expenses	Pearson Correlation	0.604**	0.705**	1	0.775**
	Sig. (2-tailed)	*1.41E-10*	*3.24742E-15*	.	*7.607E-20*
FB revenue	Pearson Correlation	0.607**	0.938**	0.775**	1
	Sig. (2-tailed)	*1.17E-10*	*1.65301E-43*	*7.607E-20*	.

** Correlation is significant at the 0.01 level (2-tailed)

The DEA model assumed input minimisation and constant returns to scale. Input minimisation was hypothesised meaning that hotels aim to maintain at least the same level of outputs (be effective) while minimising inputs (be efficient). The assumption of constant returns to scale was tested by correlating the efficiency score (FB) with the total FB capacity, as the latter is considered as a metric that directly reflects size of operations. As there was no significant correlation (Table 9.2.2.1.d), meaning that size of operation does not significantly affect FB efficiency, the assumption of constant returns to scale was maintained in the calculation of the following DEA models.

Determining the DEA input/output factors for Step 2

The efficiency score at step 1 (FB1) was correlated with input (Table 9.2.2.1.d) and output (Table 9.2.2.1.e) factors in order to investigate whether any of the latter significantly affected productivity and so needed to be included into the DEA model. Total business variability (i.e. both weekly and annually) was the only factor that significantly correlated with FB1 (Table 9.2.2.1.d) and it was so incorporated in the calculation of the efficiency score at the next step (step 2). Variability has an impact on resource utilisation and can negatively affect the efficiency of an operating system, i.e. the lower the variability the higher the efficiency. However, the positive correlation shown in Table 9.2.2.1.d is explained when considering the way in which variability in business was measured in order to incorporate it into the DEA model. Moreover, as business variability is considered as an uncontrollable input in the DEA model, the calculation of the efficiency score in step 2 had to assume output maximisation. An input minimisation assumption is not achievable, since managers cannot minimise (determine) variability. Nevertheless, despite the fact that efficiency in step 1 was calculated assuming input minimisation, comparisons of the efficiency scores derived in different steps can still be conducted because constant returns were assumed (as previously mentioned constant returns to scale give the same efficiency score under both efficiency goal assumptions, i.e. input minimisation and output maximisation).

Although variability cannot be controlled, it can be managed in order to eliminate its negative effect on efficiency. DEA compares like with like and thus by incorporating business variability as an uncontrollable input in step 2, we allowed for hotels with the same level of variability to be compared together. In other words, hotels that do achieve a higher (lower) level of inputs/outputs relative to their peers in similar business fluctuations are considered as efficient (inefficient). Specifically, in favourable business fluctuations, i.e. high score of the uncontrollable input, hotels that exploit this and achieve better levels of inputs/outputs than their peers are considered as efficient, while in situations of high fluctuations in demand, only hotels that can more successfully manage variability and achieve better levels of inputs/outputs than their peers are considered as efficient. In other words, by including the variability factor as an input in the DEA model, we consider how well hotels succeed to manage or exploit business fluctuations for achieving productivity gains (increase outputs and/or decrease inputs).

For distinguishing between hotels that successfully coped with variability and those that did not, results from the stepwise DEA were used. Hotels whose efficiency score increased between step 1 and 2 can successfully manage or exploit business fluctuations for achieving high productivity gains, while hotels whose efficiency score decreased between steps 1 and 2 did not manage or exploit business fluctuations for achieving productivity gains as well as their peers.

Specifically, as Table 9.2.2.1.b illustrates, in step 1 only hotels with a high score in variability (i.e. low fluctuations in demand) were found to be efficient. This is a biased efficiency model since only hotels that are faced with favourable environmental factors are considered as efficient. In the step 2 (FB2), when the environmental factor is taken into consideration, hotels that were faced with unfavourable situations, (i.e. low variability score, high fluctuations), but that could achieve better input/output levels relative to their peers facing the same conditions became efficient (the number of efficient units between step 1 and 2 increased from 6 to 15). Of course, the opposite is true as well, meaning that hotels that achieved lower levels of input/outputs than their peers in similar variability situations became less efficient. When comparing the efficiency scores of hotels between step 1 and 2 it was found that the efficiency score of 7 units decreased when the variability factors was incorporated. Specifically, a unit considered as efficient in step 1, that faced very favourable environmental situations, became inefficient in step 2, which essentially means that this unit does not exploit market circumstances as well as its peers (the number of efficient units with a variability score 6 decreased from 6 to 5, Table 9.2.2.1.b).

It is also evident that by incorporating the variability factor in the DEA model, the great differences in the average variability score between hotels in different efficient categories disappeared between step 1 and 2 (Table 9.2.2.1.c). Correlation between the FB2 (as well as the efficiency score of the following steps) and the variability metrics was not anymore found as significant (Table 9.2.2.1.d). These two facts meant that the full impact of the variability factor on efficiency had been taken into consideration and that it did not anymore contribute to any (in)efficiencies.

Table 9.2.2.1.b Effect of variability in efficiency

	Variability score	Number of hotels	
		FB1	**FB2**
Efficient hotels	1	0	6
	2	0	3
	4	0	1
	6	6	5
	Average score	*6*	*3.067*
	Total	**6**	**15**
Inefficient hotels with an inefficient score above the media inefficient score	1	7	7
	2	11	10
	3	1	1
	4	14	11
	6	8	11
	Average score	*3.152*	*3.447*
	Total	41	40
Inefficient hotels with an inefficient score below the media inefficient score	1	11	5
	2	11	9
	3	1	1
	4	16	18
	6	6	4
	9	1	1
	Average score	*3.317*	*3.5*
	Total	**46**	**38**

<u>Determining the DEA input/output factors for Step 3</u>

Correlations between the efficiency score in step 2 (FB2) and input (Table 9.2.2.1.d) and output (Table 9.2.2.1.e) factors were conducted in order to investigate whether productivity is affected by any other factor. Moreover, because when the factor business variability was incorporated in the DEA efficiency model (step 2), hotels that effectively and efficiently managed or exploited this factor increased their efficiency score or become efficient, it is argued that significant correlations between inputs/outputs and FB2: a) identify factors that determine the efficiency in step 2; and thus, b) illustrate how hotels manage business variability in order to achieve productivity gains. For example, it was expected to find significant correlations between FB2 and factors such as the number of full time and part time employees as well as the proportion of total payroll paid for full time staff. However, that was not the case (the correlation between FB2 and the proportion of total payroll paid for full time increased but still was not significant), but it should not be surprising as the latter variable does not take into consideration the working hours as well as the proportion of payroll paid for full time employees in FB division only.

On the contrary, a significant positive correlation was found between FB2 and number of banqueting covers served, while the correlations between FB2 and the other two of the DEA input factors, i.e. FB payroll and non-payroll FB expenses (i.e. material and other) were increased at a statistically significant level. These correlations are not surprising since banqueting functions can standardise the output and so the materials required to produce it, smooth the flow of staff work and FB material processing, which can in turn significantly positively affect efficiency, while on the contrary restaurant covers are more likely to relate with more slack resources (mainly labour) and more costly to produce outputs. However, the significant correlations of FB2 with the two DEA input factors illustrate that the DEA efficiency model in step 2 is not complete and robust since the already included factors in the model cannot effectively discriminate between units that make efficient or inefficient use of these two resources. Thus, the number of banqueting covers served, which was expected to affect input utilisation as it was found to correlate with efficiency, was incorporated in the DEA model in step 3 and the efficiency score was calculated again (FB3).

Determining the DEA input/output factors for Step 4

In order to test the robustness of the DEA model in step 3, the FB3 was correlated with input/output factors (Table 9.2.2.1.d and Table 9.2.2.1.e). FB3 was calculated by including the number of banqueting covers served, which allowed hotels that could effectively provide banqueting covers to become efficient or increase their efficiency score. FB3 correlated significantly with:

- the number of banqueting covers served;
- the percentage of banqueting covers to restaurant covers;
- the percentage of banqueting covers to total covers;
- the percentage of restaurant covers to total covers;
- and the total number of covers served;
- total FB payroll;
- the number of restaurant seats;
- total FB capacity.

Such correlations are not surprising when considering the resource efficiencies that banqueting relative to restaurant covers can have in terms of the amount and complexity of co-ordinating working time, material and human resources. However, because of these correlations the DEA efficiency model was not considered as robust since more factors had to be taken into consideration.

Because the FB3 correlated with metrics that incorporated the restaurant covers, e.g. percentage of restaurant covers to total covers, while it did not correlate with the number of restaurant covers per se, it was considered that the efficiency score in the following step should incorporate a factor that would consider restaurant covers only indirectly. As the percentage of banqueting to restaurant covers significantly correlated more than the other factors, the former factor was included in step 4 and the efficiency score was calculated again (FB4).

Determining the most robust DEA FB efficiency model

In order to test the robustness of the DEA model in step 4, FB4 was correlated with input (Table 9.2.2.1.d) and output (Table 9.2.2.1.e) factors. Since no significant correlations were found, the robustness of the DEA efficiency model was confirmed.

The robustness of the DEA efficiency models was also double checked by investigating correlations between FB4 and metrics of profitability and revenue. As significant and strong positive correlations were found (Table 9.2.2.1.e), the efficiency model in step 4 provided robust efficient scores that could effectively identify efficient units that also scored high in profits and FB revenue. The fact that less than perfect correlations were found demonstrates that some hotels are profitable without necessarily being efficient, meaning that some other factors/inputs/outputs contribute to profitability apart from FB efficiency.

Step 5

Because calculations in step 4 might had been affected by the use of the metric banquet to restaurant covers instead of another factor, the following tests were also conducted for confirming the robustness of the DEA model in step 4. An efficiency score was calculated in step 5 by incorporating the two metrics namely percentage of restaurant covers to total covers and percentage of banqueting covers to total covers instead of the metric percentage of banqueting to restaurant covers, as was the case in step 4. By calculating the new DEA model the efficiency score in step 5 was derived (FB5), which was then correlated with input/output factors in order to test its robustness (Table 9.2.2.1.d and 9.2.2.1.e). FB5 significantly correlated with the business variability factor, while the correlations between FB5 and FB revenue as well as percentage of FB revenue in hotel profit were not anymore significant. As variability could still further contribute and determine efficiency, although it was already included in the model, and as FB5 provided efficient hotels that scored low in FB revenue and hotel profitability, the robustness of the DEA efficiency score in step 5 was not validated and the DEA efficiency model in step 4 was concluded as the most robust FB efficiency model.

Table 9.2.2.1.c Input and output metrics included in the stepwise DEA in FB

	FB 1 (Input min)	**FB 2** (Output max)	**FB 3** (Output max)	**FB 4** (Output max)	**FB 5** (Output max)
Outputs					
FB total revenue	*	*	*	*	*
Percentage of banqueting covers to total covers			*		*
Percentage of restaurant covers to total covers					*
Banquet to restaurant covers ratio				*	
Inputs					
Total FB capacity (banqueting and restaurant)	*	*	*	*	*
FB payroll	*	*	*	*	*
FB non payroll expenses (material & other)	*	*	*	*	*
Total variability (uncontrollable input)		*	*	*	*

Table 9.2.2.1.d Correlations of FB efficiency scores with FB input variables

		FB 1	FB2	FB3	FB4	FB5
Yearly variability	Pearson Correlation	[redacted]	-0.007	-0.022	0.008	-0.261
	Sig. (2-tailed)	*0.002*	*0.950*	*0.832*	*0.939*	*0.011*
Weekly variability	Pearson Correlation	0.241	-0.065	-0.025	-0.034	[redacted]
	Sig. (2-tailed)	*0.020*	*0.539*	*0.808*	*0.744*	*0.001*
Total variability	Pearson Correlation	[redacted]	-0.012	-0.013	0.010	[redacted]
	Sig. (2-tailed)	*0.001*	*0.905*	*0.903*	*0.925*	*0.003*
Percentage of roomnights from repeat customers	Pearson Correlation	[redacted]	0.246	0.205	0.232	0.134
	Sig. (2-tailed)	*0.005*	*0.001*	*0.003*	*0.001*	*0.201*
Percentage of roomnights of business travellers	Pearson Correlation	-0.166	-0.100	-0.116	-0.104	-0.081
	Sig. (2-tailed)	*0.113*	*0.340*	*0.267*	*0.322*	*0.443*
Percentage of roomnights of leisure travellers	Pearson Correlation	0.119	0.058	0.069	0.070	0.096
	Sig. (2-tailed)	*0.254*	*0.581*	*0.511*	*0.504*	*0.357*
Percentage of roomnights from conference	Pearson Correlation	0.096	0.020	0.022	0.018	-0.038
	Sig. (2-tailed)	*0.361*	*0.848*	*0.834*	*0.862*	*0.719*
Occupancy	Pearson Correlation	0.019	-0.050	-0.011	-0.030	-0.243
	Sig. (2-tailed)	0.854	0.635	0.915	0.779	0.019
Total capacity (banqueting and restaurant)	Pearson Correlation	-0.105	0.156	0.215	0.136	-0.114
	Sig. (2-tailed)	*0.317*	*0.136*	*0.039*	*0.193*	*0.276*
Total number of restaurant seats	Pearson Correlation	-0.034	0.145	0.249	0.160	-0.023
	Sig. (2-tailed)	*0.747*	*0.165*	*0.016*	*0.125*	*0.829*
Banqueting capacity (seats)	Pearson Correlation	-0.116	0.142	0.180	0.114	-0.131
	Sig. (2-tailed)	*0.270*	*0.173*	*0.085*	*0.278*	*0.211*
Total FB non payroll expenses (material & other)	Pearson Correlation	-0.095	[redacted]	-0.206	-0.220	-0.059
	Sig. (2-tailed)	*0.452*	*0.195*	*0.165*	*0.134*	*0.576*
Total FB payroll	Pearson Correlation	-0.216	[redacted]	[redacted]	-0.209	-0.082
	Sig. (2-tailed)	*0.092*	*0.000*	*0.000*	*0.301*	*0.435*
FB other expenses	Pearson Correlation	-0.079	-0.136	-0.145	0.166	0.103
	Sig. (2-tailed)	*0.381*	*0.034*	*0.055*	*0.012*	*0.339*
FB material expenses	Pearson Correlation	-0.099	-0.187	-0.211	-0.201	0.013
	Sig. (2-tailed)	*0.344*	*0.073*	*0.043*	*0.111*	*0.900*
Roomnights	Pearson Correlation	-0.150	-0.165	-0.112	-0.146	-0.101
	Sig. (2-tailed)	*0.152*	*0.113*	*0.286*	*0.164*	*0.334*
Number of full time FB staff	Pearson Correlation	-0.053	-0.172	-0.157	-0.136	-0.150
	Sig. (2-tailed)	*0.612*	*0.099*	*0.132*	*0.193*	*0.150*
Proportion of total hotel payroll for full time staff	Pearson Correlation	-0.152	-0.183	-0.152	-0.153	-0.040
	Sig. (2-tailed)	*0.146*	*0.172*	*0.146*	*0.143*	*0.707*
Total expenses for training on IT	Pearson Correlation	0.007	0.001	0.055	0.015	-0.119
	Sig. (2-tailed)	*0.948*	*0.992*	*0.604*	*0.886*	*0.256*

[redacted] *Correlation is significant at the 0.01 level (2-tailed).*

* *Correlation is significant at the 0.05 level (2-tailed).*

Table 9.2.2.1.e Correlations of FB efficiency scores with FB output variables

		FB 1	FB2	FB3	FB4	FB5
Number of restaurant covers served	Pearson Correlation	-0.048	0.086	0.147	0.128	-0.160
	Sig. (2-tailed)	*0.649*	*0.412*	*0.159*	*0.222*	*0.124*
Number of banqueting covers served	Pearson Correlation	0.049	0.206	[redacted]	0.140	0.032
	Sig. (2-tailed)	*0.642*	*0.047*	*0.001*	*0.121*	*0.764*
Percentage of banqueting covers to restaurant covers	Pearson Correlation	0.094	0.190	[redacted]	0.196	0.164
	Sig. (2-tailed)	*0.371*	*0.068*	*0.000*	*0.147*	*0.117*
Percentage of banqueting covers to total covers served	Pearson Correlation	0.040	0.200	[redacted]	0.201	0.169
	Sig. (2-tailed)	*0.705*	*0.055*	*0.003*	*0.142*	*0.104*
Percentage of restaurant covers to total covers	Pearson Correlation	-0.040	-0.200	[redacted]	-0.201	-0.169
	Sig. (2-tailed)	*0.705*	*0.055*	*0.003*	*0.142*	*0.104*
Total covers served	Pearson Correlation	-0.018	0.130	[redacted]	0.171	-0.103
	Sig. (2-tailed)	*0.867*	*0.214*	*0.035*	*0.102*	*0.325*
FB revenue	Pearson Correlation	[redacted]	[redacted]	[redacted]	[redacted]	0.158
	Sig. (2-tailed)	*0.000*	*0.000*	*0.000*	*0.000*	*0.130*
Percent of FB revenue to total hotel revenue	Pearson Correlation	0.194	0.136	0.131	0.128	-0.062
	Sig. (2-tailed)	*0.062*	*0.193*	*0.212*	*0.221*	*0.558*
Percentage of room revenue in hotel profit	Pearson Correlation	0.056	0.160	0.180	0.078	0.002
	Sig. (2-tailed)	*0.593*	*0.126*	*0.084*	*0.456*	*0.985*
Percentage of FB revenue in hotel profit	Pearson Correlation	[redacted]	[redacted]	[redacted]	[redacted]	0.114
	Sig. (2-tailed)	*0.049*	*0.010*	*0.021*	*0.006*	*0.276*
Hotel profit	Pearson Correlation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Sig. (2-tailed)	*0.000*	*0.001*	*0.002*	*0.000*	*0.003*

[redacted] *Correlation is significant at the 0.01 level (2-tailed).*

* *Correlation is significant at the 0.05 level (2-tailed).*

9.2.2.2 Factors that determine efficiency in FB

The stepwise approach to DEA identified the factors, input/outputs that determine efficiency in FB based on the data gathered from the sample respondents. Analytically, the outputs/inputs that determine the efficiency frontier in FB were found to be: total FB capacity (restaurant seats plus banqueting capacity), FB revenue, FB payroll, FB non-payroll expenses (material and other expenses), business variability and the percentage of banqueting to restaurant covers served. In particular, it was found that hotels that managed to do the best utilisation of their FB capacity by achieving high FB revenue and serving more banqueting than restaurant covers with minimum inputs, (both FB payroll and non-payroll expenses), while controlling for fluctuations in business, were found to be efficient.

However, in order to better illustrate the factors that constructed the efficiency frontier in FB as well as demonstrate the robustness of the FB4 model, the same rationale and process as in rooms division was followed. In short, the average and percentages scores of inputs/outputs for three hotel efficiency categories were calculated using the efficiency scores at all steps and the radar plots were constructed (Table 9.2.2.2.a, Figures 9.2.2.2.a, 9.2.2.2.b, 9.2.2.2.c and 9.2.2.2.d). Percentages instead of raw average scores were again calculated and used in order to convert the measurement of all inputs/outputs in the same percentage measurement scale and so allow comparisons between the inputs/outputs configuration of hotels with an inefficiency score above/below the media inefficiency score with the inputs/outputs configuration of the efficient hotels. The configuration of the input/outputs was again calculated for all DEA steps in order to illustrate how the robust DEA model clearly identifies efficient units with an efficient frontier that incorporates the frontier of the inefficient units.

Although, it was found that it was the total FB capacity rather than both the restaurant and banqueting capacity that determined efficiency, average and percentage scores are given for both the two latter analytical metrics of FB capacity. This is because the ratio of banqueting to restaurant covers was found to be one factor determining FB efficiency and so it was considered as worthwhile investigating how efficient and inefficient hotels make use of their restaurant and banqueting capacity separately rather than as a whole.

Table 9.2.2.2.a Average and percentages scores of inputs/outputs per efficiency category

		FB1	FB2	FB3	FB4	*1%*	*2%*	*3%*	*4%*
Efficient units	**Restaur. seats**	86.17	124.47	126.85	123.72	*1.000*	*1.000*	*1.000*	*1.000*
	Banq. Cap.	80.00	227.33	254.00	205.55	*1.000*	*1.000*	*1.000*	*1.000*
	FB.M.O	319611.00	332472.93	368766.70	384701.89	*1.000*	*1.000*	*1.000*	*1.000*
	F.B.PAY	470963.00	577830.93	594862.30	572266.33	*1.000*	*1.000*	*1.000*	*1.000*
	FB.£ (rev)	2053078.47	2157883.40	2190238.42	2173013.96	*1.000*	*1.000*	*1.000*	*1.000*
	BAN/REST	0.19	0.54	0.58	0.59	*1.000*	*1.000*	*1.000*	*1.000*
	TOT.VAR	6.00	3.06	3.10	3.28	*1.000*	*1.000*	*1.000*	*1.000*
with an inefficient score above the median inefficiency score	**Restaur. seats**	106.48	109.97	115.59	109.26	*1.236*	*0.884*	*0.911*	*0.883*
	Banq. Cap.	194.24	191.42	171.00	192.55	*2.428*	*0.842*	*0.673*	*0.937*
	FB.M.O	335027.61	380204.05	362622.73	364195.31	*1.048*	*1.144*	*0.983*	*0.947*
	F.B.PAY	358146.72	437595.92	400615.51	417786.52	*0.760*	*0.757*	*0.673*	*0.730*
	FB.£ (rev)	1077583.72	1641895.87	1511168.17	1569126.97	*0.525*	*0.761*	*0.690*	*0.722*
	BAN/REST	0.28	0.40	0.39	0.34	*1.535*	*0.739*	*0.665*	*0.575*
	TOT.VAR	3.15	3.50	3.51	3.34	*0.525*	*1.141*	*1.133*	*1.020*
with an inefficient score below the median inefficiency score	**Restaur. seats**	116.09	102.89	93.36	102.59	*1.347*	*0.826*	*0.736*	*0.829*
	Banq. Cap.	204.32	176.97	177.36	183.11	*2.554*	*0.778*	*0.698*	*0.891*
	FB.M.O	343255.24	294924.87	294722.94	287522.84	*1.074*	*0.887*	*0.799*	*0.747*
	F.B.PAY	437355.34	291073.55	292002.11	298794.97	*0.929*	*0.504*	*0.491*	*0.522*
	FB.£ (rev)	1687751.34	869501.08	871309.34	874163.54	*0.822*	*0.403*	*0.398*	*0.402*
	BAN/REST	0.46	0.22	0.18	0.25	*2.468*	*0.410*	*0.314*	*0.420*
	TOT.VAR	3.32	3.44	3.47	3.54	*0.553*	*1.124*	*1.120*	*1.080*

Productivity comparisons in step 1

As the above Table 9.2.2.2.a and the Figure 9.2.2.2.a below illustrate, in step 1, inefficient hotels have approximately the 250% of the banqueting capacity and the 125% of the restaurant capacity of the efficient hotels. However, despite their greater FB capacity, inefficient hotels below and above the media achieve only the 82% and 52% of the FB revenue of the efficient hotels respectively, meaning that they do not fully exploit their FB capacity (slack/underused resources). Moreover, inefficient hotels achieve the lower revenue with the use of more than the expected proportional amount of resources, e.g. inefficient hotels below the media achieve the 82% of the revenue of efficient hotels with the use of 92% of the payroll and 107% of the non-payroll of the efficient units, i.e. 10% more payroll and 25% more non-payroll expenses than the efficient units would have used for the same level of revenue. However, the inefficient units were faced with greater business fluctuations that efficient units (the score of business variability for inefficient hotels is half of that of efficient hotels) and served more banqueting to restaurant covers. The last two factors were expected to have influenced efficiency and since their correlations with FB1 were found statistically significant, they were incorporated into the following DEA FB efficiency models. By doing so, we allowed hotels that effectively managed variability in business as well as exploited their greater and more efficiency promising banqueting capacity to become efficient or increase their efficiency score.

Productivity comparisons in step 4

As concerns the inputs/outputs configurations of efficient and inefficient units in the most robust FB model, i.e. FB4 at step 4, the following issues are found. Below the media inefficient units have the 82% and 89% of the restaurant and banqueting capacity of the efficient units but they achieve proportionally less revenue than the efficient units would have achieved with the same capacity (slack/underused resources), i.e. they achieve 40% of the efficient units revenue meaning approximately 40% (82% -40%) less revenue than what they would have been expected to achieve. Below the media inefficient units also make a proportionally greater use of resources. They achieve the 40% revenue of efficient units with 52% and 74% of the payroll and non-payroll expenses of the efficient units, meaning that they overspend 12% (52% -40%) in payroll and 34% (74% - 40%) in non-payroll expenses than they would have been expected if they were going to be considered as efficient.

On the other hand, above the media inefficient units are doing better than below the media inefficient units in terms of using their capacity and controlling their expenses. In particularly, above the media inefficient units have the 88% and 93% of the restaurant and banqueting capacity of efficient units (they are so of greater banqueting capacity of units below the media) but they achieve the 72% of the revenue of the efficient units, meaning approximately 18% less revenue than expected (instead of 40% as the below the media units). In the same vein, the 72% revenue is achieved with the 73% of payroll and the 94% of the non-payroll of the efficient units, which means that actually units above the media can control their payroll as efficient as the efficient units (only 73%-72%=1% expected difference), while they are overspending in terms of non-payroll expenses (94% -72%=22%), but which is still less than that of the below media units.

The inefficiencies of the inefficient units can be explained by the fact that they serve less banqueting than restaurant covers than the efficient units do. Indeed, inefficient units serve approximately half the amount of the banqueting covers served by efficient units as well as the below the media units, i.e. the very inefficient units, had a lower ratio of banqueting to restaurant covers served than the above media units, i.e. the less inefficient units. Moreover, all efficiency categories of hotels had approximately the same variability score, meaning that the DEA efficiency model has controlled for the effect of the variability of business on efficiency and that business variability was not anymore a factor that could have attributed to efficiency.

The inputs/outputs configuration can also be described from the efficient units perspective in order to approach the construction of the efficient frontier from another dimension and have a greater insight of the analysis. Thus, by comparing efficient units with the above the media inefficient units, the former are 12% (100% - 88%) and 7% (100-93%) of greater restaurant and banqueting capacity respectively, but they achieve 28% more revenue (a bigger revenue percentage than the percentage difference in capacity, i.e. 7% and 12%, and thus they make more use of their capacity) but by spending 6% and 26% less non-payroll and payroll expenses (a lower percentage than the percentage in revenue, i.e. 28%, and thus can better control their expenses in producing outputs) than the latter. Efficient units are argued to achieve this because they serve 43% more banqueting to restaurant covers than below the media inefficient units.

In the same vein, when comparing efficient units with below the media inefficient units, the former are 18% and 11% of bigger restaurant and banqueting capacity, but achieve 60% more revenue (a much greater percentage than the percentage difference in capacity, i.e. 18% and 11%) by spending 48% less payroll and 26% less non-payroll expenses (a much lower percentage than the percentage difference in revenue, i.e. 60%) than the latter. Efficient units are argued to achieve this because they serve 58% more banqueting to restaurant covers than below the media inefficient units. The inefficiencies of the inefficient units cannot be attributed to the business variability factor because its affect has been controlled, i.e. it has been included in the model, which is also illustrated in the fact that all efficient category hotels have approximately the same variability score.

The following radar plots were constructed in order to illustrate how the productivity determinant factors construct the efficiency frontiers of the three efficiency categories of hotels at steps 1, 2, 3 and 4. The efficiency frontier of the efficiency units at the most robust DEA model, i.e. at step 4, is clearly greater than the one in previous steps.

Figure 9.2.2.2.a Configuration of the inputs/outputs in FB1 DEA efficiency model

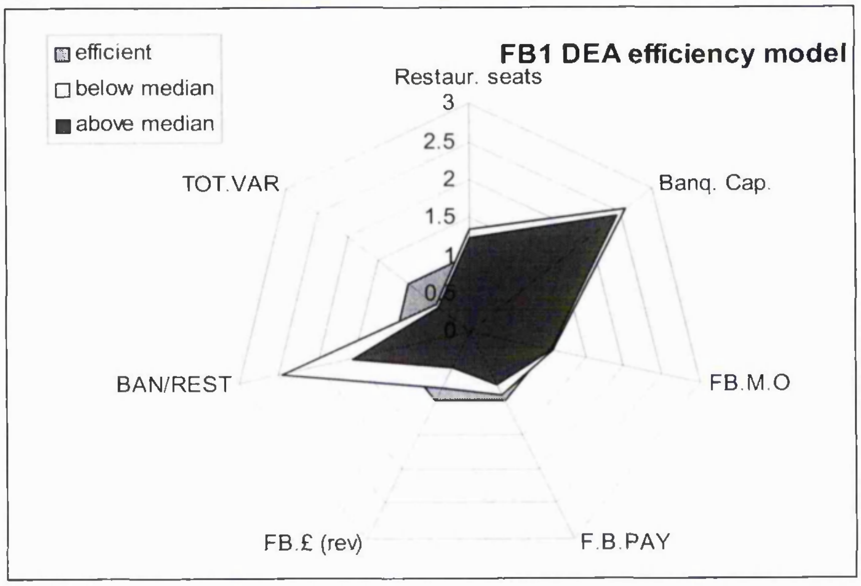


Figure 9.2.2.2.b Configuration of the inputs/outputs in FB2 DEA efficiency model

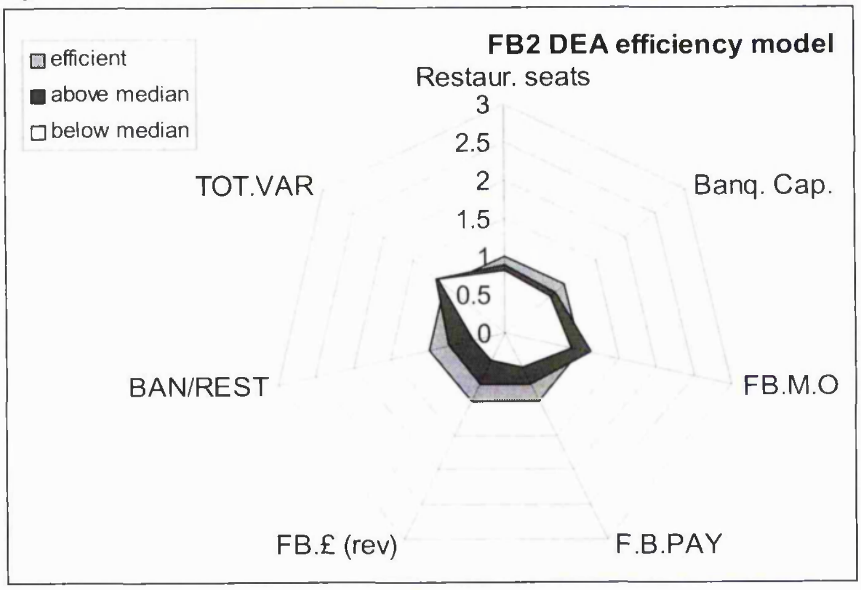


Figure 9.2.2.2.c Configuration of the inputs/outputs in FB3 DEA efficiency model

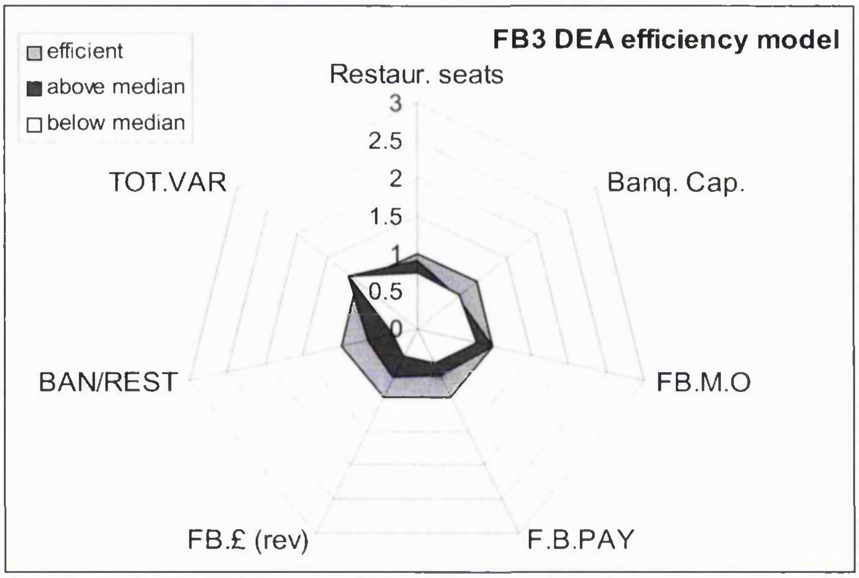
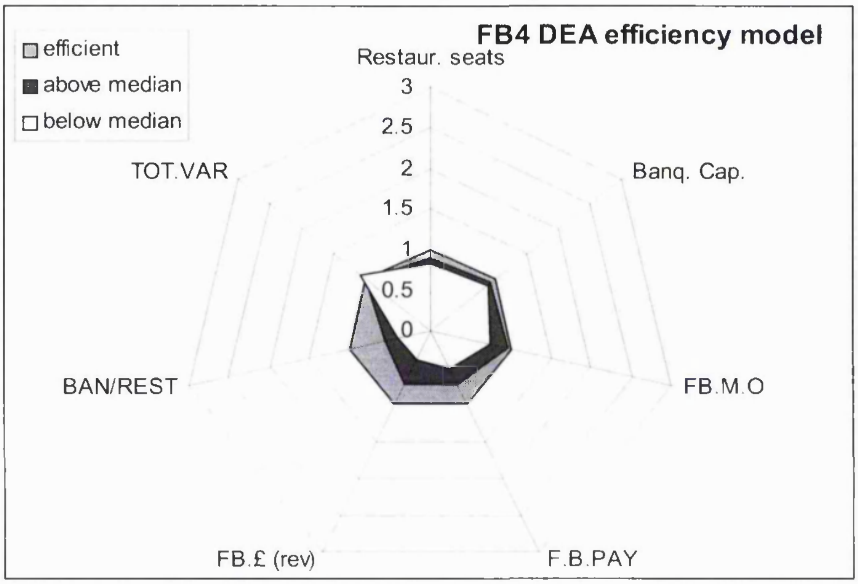


Figure 9.2.2.2.d Configuration of the inputs/outputs in FB4 DEA efficiency model



Apart from the factors that were found to affect efficiency in FB, the following factors were not found to have a significant impact on efficiency as no significant correlations were found between them and the efficiency score (Tables 9.2.2.1.d and 9.2.2.1.e): roomnights from repeat customers; roomnights per market segment (business, leisure, conference); occupancy; roomnights; number of full time FB staff; proportion of total hotel payroll for full time staff; total expenses for training on IT; number of restaurant covers served; revenue orientation of hotel (i.e. percentage of FB revenue to total hotel revenue).

9.2.2.3 Distinguishing between operational and market efficiency

Because the business variability factor was incorporated into the DEA model from the very early DEA model configuration steps, it is not possible to distinguish market from operational efficiency by following the same procedure as in rooms division. However, it is evident that FB4 efficiency model is a combined model that identifies hotels that are both operational and market efficient.

9.2.3 Overall hotel property efficiency

9.2.3.1 Construction of the overall hotel DEA efficiency model

The overall hotel property efficiency was calculated by using input and output factors that were previously identified to affect efficiency in rooms and FB division. The inputs and outputs used for the DEA model are illustrated in Table 9.2.3.1.a below. The Tot.oper DEA model assumed constant returns to scale (which was later confirmed and maintained since the efficiency score did not correlate with the number of rooms as well as the FB capacity) and input minimization.

Table 9.2.3.1.a Input and output metrics included in the overall hotel DEA model

	Tot.oper (Input min)
Outputs	
ARR	*
Roomnights	*
Non-room revenue	*
FB total revenue	*
Inputs	
Number of rooms	*
Total FB capacity (banqueting and restaurant)	*
Front office payroll	*
Administration non-payroll expenses (material & other)	*
FB payroll	*
FB non payroll expenses (material & other)	*
Other payroll	*
Other non-payroll expenses	*

However, the factor business variability was not included in the Tot.oper DEA model, although the former was found to significantly affect efficiency in both Rooms and FB division. This was deliberately done in order to be able to distinguish between market and operational efficiency separately. Thus, the Tot.oper DEA model measures and reflects hotel overall operational efficiency only. Moreover, the Tot.oper DEA model included 4 output factors and 8 input factors meaning that there are at least 4X8=32 combinations in which units can be efficient, (i.e. at least 32 units). As the DEA methodology requires a sample of units that is at least three times bigger than the number of possible efficient units (i.e. a sample of at least 32X3=96 units) in order efficiently to discriminate between units, the tot.oper DEA model with a research sample of 93 units was just on this sample size limit. That meant that it would not have also been methodologically correct to include one more factor in the DEA, as this would had increased the required sample size.

In order to test the robustness of this hotel overall operational efficiency model, correlations between Tot.oper and input/output factors were conducted (Tables 9.2.3.1.c and 9.2.3.1.d). The significant correlations between Tot.oper and rooms division non-payroll and payroll expenses confirm the inclusion of front office payroll and administration non-payroll expenses (constituent parts of rooms division expenses) as efficiency determining factors. Tot.oper significantly correlated with hotel profit and hotel revenue, which also confirmed the robustness of the model. Tot.oper also correlated with the percentage of reservations coming from the Internet and the number of part time staff. Internet reservations can increase hotel efficiency as they usually involve lower or no commissions and probably less front office/telephone expenses. The fact that hotels that use more part time staff are found more operational efficient is not surprising, but correlations between number of part time staff and business variability, which was also found to effect operational efficiency, may confound any conclusion regarding the size of the effect of part time staff on efficiency. However, when correlations between total business variability and part time staff were conducted not significant correlations were found (Table 9.2.3.1.b). On the other hand, no reliable conclusions can be derived from this, since the metric number of part time staff is limited by the fact that does not reflect the actual number of hours worked.

Table 9.2.3.1.b Correlation between number of part time staff and variability scores

		Number of part time staff	Total variability	yearly variability	weekly variability
PART.TIM	Pearson Correlation	1	-.015	-.022	.042
	Sig. (2-tailed)	.	*.886*	*.833*	*.691*
TOT.VAR	Pearson Correlation	-.015	1	.842	.789
	Sig. (2-tailed)	*.886*	.	*.000*	*.000*
year variance	Pearson Correlation	-.022	.842	1	.378
	Sig. (2-tailed)	*.833*	*.000*	.	*.000*
week variance	Pearson Correlation	.042	.789	.378	1
	Sig. (2-tailed)	*.691*	*.000*	*.000*	.

** Correlation is significant at the 0.01 level (2-tailed).

Indeed, the significant correlations between Tot.oper and business variability (Table 9.2.3.1.c) illustrate that total hotel operational efficiency is influenced by variability in business, which was though expected because of the previous findings in both FB and rooms division efficiency analyses. As business variability was the only factor that significantly correlated with Tot.oper and so the only factor that was identified to affect total hotel operational efficiency, it is evident that the former should be included in the DEA model. However, as mentioned before because of the number of hotel units of the research sample it was impossible to incorporate another variable in the DEA model. For that reason and in order to to identify hotels that are operational, market and/or both efficient the following analysis was conducted.

Table 9.2.3.1.c Correlations of Tot.oper with input factors

		TOT.OPER
Yearly variability	Pearson Correlation	0.283
	Sig. (2-tailed)	*0.048*
Weekly variability	Pearson Correlation	0.213
	Sig. (2-tailed)	*0.039*
Total variability	Pearson Correlation	0.336
	Sig. (2-tailed)	*0.022*
Percentage of roomnights from repeat guests	Pearson Correlation	0.191
	Sig. (2-tailed)	*0.066*

		Continued...
% of reservations from property based system	Pearson Correlation	-0.040
	Sig. (2-tailed)	*0.696*
% of reservations from third party	Pearson Correlation	0.018
	Sig. (2-tailed)	*0.856*
% of reservations from Internet (88 units with website)	Pearson Correlation	0.239
	Sig. (2-tailed)	*0.024*
Number of rooms	Pearson Correlation	0.056
	Sig. (2-tailed)	*0.589*
Length of stay (in days)	Pearson Correlation	0.104
	Sig. (2-tailed)	*0.316*
Total FB capacity	Pearson Correlation	-0.115
	Sig. (2-tailed)	*0.268*
Number of restaurant seats	Pearson Correlation	-0.070
	Sig. (2-tailed)	*0.504*
Banqueting capacity (in covers)	Pearson Correlation	-0.117
	Sig. (2-tailed)	*0.260*
Number of restaurant covers served	Pearson Correlation	0.007
	Sig. (2-tailed)	*0.944*
Number of banqueting covers served	Pearson Correlation	0.082
	Sig. (2-tailed)	*0.431*
Number of full time staff in hotel property	Pearson Correlation	0.201
	Sig. (2-tailed)	*0.052*
Number of part time staff in hotel property	Pearson Correlation	0.208
	Sig. (2-tailed)	*0.044*
Number of managers	Pearson Correlation	0.133
	Sig. (2-tailed)	*0.200*
Number of IT staff	Pearson Correlation	-0.048
	Sig. (2-tailed)	*0.644*
Number of full time rooms division staff	Pearson Correlation	0.176
	Sig. (2-tailed)	*0.091*
Number of full time front office staff	Pearson Correlation	0.196
	Sig. (2-tailed)	*0.059*
Number of full time housekeeping staff	Pearson Correlation	0.191
	Sig. (2-tailed)	*0.066*
Number of full time F.B staff	Pearson Correlation	0.202
	Sig. (2-tailed)	*0.051*
Number of full time telephone staff	Pearson Correlation	-0.059
	Sig. (2-tailed)	*0.568*
Number of full time administration staff	Pearson Correlation	0.034
	Sig. (2-tailed)	*0.742*
Number of full time marketing staff	Pearson Correlation	0.190
	Sig. (2-tailed)	*0.066*
Number of full time minor operations staff	Pearson Correlation	0.226
	Sig. (2-tailed)	*0.028*
Number of full time maintenance staff	Pearson Correlation	0.108
	Sig. (2-tailed)	*0.300*
Proportion of hotel payroll paid for full time staff	Pearson Correlation	-0.150
	Sig. (2-tailed)	*0.151*
Non-payroll rooms division expenses	Pearson Correlation	-0.401
	Sig. (2-tailed)	*0.000*

		Continued...
Payroll rooms division expenses	Pearson Correlation	-0.252
	Sig. (2-tailed)	*0.045*
Non-payroll FB expenses	Pearson Correlation	-0.017
	Sig. (2-tailed)	*0.865*
FB payroll	Pearson Correlation	0.114
	Sig. (2-tailed)	*0.275*
Front office total expenses	Pearson Correlation	-0.234
	Sig. (2-tailed)	*0.051*
Front office non-payroll expenses	Pearson Correlation	0.059
	Sig. (2-tailed)	*0.572*
Housekeeping total expenses	Pearson Correlation	-0.038
	Sig. (2-tailed)	*0.714*
Housekeeping non-payroll expenses	Pearson Correlation	-0.008
	Sig. (2-tailed)	*0.937*
Housekeeping payroll	Pearson Correlation	-0.053
	Sig. (2-tailed)	*0.609*
Telephone total expenses	Pearson Correlation	-0.049
	Sig. (2-tailed)	*0.637*
Telephone non-payroll expenses	Pearson Correlation	0.063
	Sig. (2-tailed)	*0.543*
Telephone payroll	Pearson Correlation	-0.103
	Sig. (2-tailed)	*0.322*
Minor operations total expenses	Pearson Correlation	0.173
	Sig. (2-tailed)	*0.096*
Minor operations non-payroll expenses	Pearson Correlation	0.134
	Sig. (2-tailed)	*0.199*
Minor operations payroll	Pearson Correlation	0.197
	Sig. (2-tailed)	*0.058*
Administration total expenses	Pearson Correlation	-0.194
	Sig. (2-tailed)	*0.053*
Administration non-payroll expenses	Pearson Correlation	-0.257
	Sig. (2-tailed)	*0.068*
Administration payroll	Pearson Correlation	0.039
	Sig. (2-tailed)	*0.704*
Marketing total expenses	Pearson Correlation	0.027
	Sig. (2-tailed)	*0.793*
Marketing non-payroll expenses	Pearson Correlation	-0.043
	Sig. (2-tailed)	*0.685*
Marketing payroll	Pearson Correlation	0.065
	Sig. (2-tailed)	*0.534*
Total maintenance expenses	Pearson Correlation	0.079
	Sig. (2-tailed)	*0.446*
Non-payroll maintenance expenses	Pearson Correlation	0.045
	Sig. (2-tailed)	*0.662*
Payroll maintenance	Pearson Correlation	0.086
	Sig. (2-tailed)	*0.411*
Total energy expenses	Pearson Correlation	0.075
	Sig. (2-tailed)	*0.471*
Total training costs for IT	Pearson Correlation	-0.008
	Sig. (2-tailed)	*0.937*

		Continued…
Total management fees expenses	Pearson Correlation	0.004
	Sig. (2-tailed)	*0.966*
*	Correlation is significant at the 0.05 level (2-tailed).	
**	Correlation is significant at the 0.01 level (2-tailed).	

Table 9.2.3.1.d Correlations between Tot.oper and output factors

		TOT.OPER
% of roominghts from business guests	Pearson Correlation	-0.026
	Sig. (2-tailed)	*0.798*
% of roominghts from leisure guests	Pearson Correlation	-0.012
	Sig. (2-tailed)	*0.907*
% of roomnights from conference guests	Pearson Correlation	0.032
	Sig. (2-tailed)	*0.756*
Occupancy	Pearson Correlation	0.220
	Sig. (2-tailed)	*0.058*
ARR	Pearson Correlation	0.258
	Sig. (2-tailed)	*0.052*
Number of restaurant covers served	Pearson Correlation	0.007
	Sig. (2-tailed)	*0.944*
Number of banqueting covers served	Pearson Correlation	0.082
	Sig. (2-tailed)	*0.4317*
Banqueting to restaurant covers served	Pearson Correlation	0.104
	Sig. (2-tailed)	*0.320*
Banqueting to total covers served	Pearson Correlation	0.096
	Sig. (2-tailed)	*0.357*
Restaurant to total covers served	Pearson Correlation	-0.096
	Sig. (2-tailed)	*0.357*
Total covers served	Pearson Correlation	0.032
	Sig. (2-tailed)	*0.755*
FB revenue	Pearson Correlation	0.206
	Sig. (2-tailed)	*0.057*
Roominghts	Pearson Correlation	0.168
	Sig. (2-tailed)	*0.106*
Non-room revenue	Pearson Correlation	0.290
	Sig. (2-tailed)	*0.005*
Total hotel revenue	Pearson Correlation	0.242
	Sig. (2-tailed)	*0.004*
Total hotel profit	Pearson Correlation	0.290
	Sig. (2-tailed)	*0.004*
Room revenue	Pearson Correlation	0.156
	Sig. (2-tailed)	*0.134*
Minor operations revenue	Pearson Correlation	0.257
	Sig. (2-tailed)	*0.053*
Telephone revenue	Pearson Correlation	0.100
	Sig. (2-tailed)	*0.339*
*	Correlation is significant at the 0.05 level (2-tailed).	
**	Correlation is significant at the 0.01 level (2-tailed).	

9.2.3.2 Determining and calculating market efficiency

The ratio profit to revenue was calculated for all hotel units. This ratio actually reflects how well hotels manage/control their expenses (as profit = revenue –

expenses) for the revenue they achieve. This ratio is a productivity metric frequently used in the hotel industry, whose robustness was checked by correlating it with Tot.oper (i.e. the robust operational efficiency score). Their correlation was found statistically significant but not perfect (Table 9.2.3.2.a), meaning that this ratio is a good metric of profitability but not an adequate metric of operational efficiency. This was, however, expected as the profits to revenue metric is a ratio of aggregate metrics that does not distinguish hotels that are efficient in break down metrics that can in turn significantly affect efficiency (as DEA does).

Table 9.2.3.2.a Correlation between profit/revenue model and Tot.oper

		PROF/REV	TOT.OPER
PROF/REV	Pearson Correlation	1	.270**
	Sig. (2-tailed)	.	*.009*
	N	93	93
TOT.OPER	Pearson Correlation	.270**	1
	Sig. (2-tailed)	*.009*	.
	N	93	93

** Correlation is significant at the 0.01 level (2-tailed).

The profits to revenue ratio was then correlated with business variability in order to identify whether business variability influence operational efficiency (Table 9.2.3.2.b). The correlation was found significant and so business variability was incorporated into the profits to revenue ratio as an uncontrollable input. By incorporating the business variability score in the profit to revenue efficiency metric, it is evident that the latter now measured and reflected the overall hotel market efficiency. In other words, the new efficiency model identifies hotels that given the market circumstances that they face they can efficiently and effectively manage their expenses for the revenue they can achieve.

Table 9.2.3.2.b Profits/revenue and business variability correlation

		TOT.VAR	PROF.REV
TOT.VAR	Pearson Correlation	1	.214*
	Sig. (2-tailed)	.	*.040*

* Correlation is significant at the 0.05 level (2-tailed).

For the calculation of the new efficiency model, a DEA was conducted, as three variables had to be simultaneously analysed. The new efficiency score (mark.ef) was calculated under the assumptions of constant returns to scale and output maximisation (as the DEA model included an uncontrollable input). As Mark.ef did not significantly correlate with business variability (Table 9.2.3.2.c), it meant that the new model had taken into consideration the full effect of business variability on market efficiency. The hypothesis of constant returns to scale was tested by correlating the efficiency score with three metrics reflecting the size of hotel operations namely the number of rooms, number of full time employees and total FB capacity metrics (Table 9.2.3.2.c).

Pearson correlations test revealed that mark.ef significantly correlated with number of full time employees and total FB capacity, meaning that market efficiency is affected by size of hotel operations and that the assumption of constant returns to scale was false. The effect of size on market efficincy is not surprising since the DEA market efficiency model did not include any metric reflecting the hotel size. Thus, the mark.ef was calculated again assuming variable returns to scale and the new market efficiency score was taken (mark.eff).

Table 9.2.3.2.c Correlations between mark.ef, business variability and metrics indicating size of hotel operations

		MARK.EF
TOT.VAR	Pearson Correlation	0.1438
	Sig. (2-tailed)	*0.169*
year variance	Pearson Correlation	0.087
	Sig. (2-tailed)	*0.405*
week variance	Pearson Correlation	0.125
	Sig. (2-tailed)	*0.231*
Rooms	Pearson Correlation	0.173
	Sig. (2-tailed)	*0.091*
FULL.TIM	Pearson Correlation	0.222
	Sig. (2-tailed)	*0.032*
TOT.SEAT	Pearson Correlation	-0.212
	Sig. (2-tailed)	*0.040*

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

In order to test the robustness of Mark.eff, this was correlated with input/output factors in order to investigate whether the former was significantly influenced by any of these (Table 9.2.3.2.d). The effect of business variability and size of operations disappeared and since no other factor was found to significantly correlate and affect mark.eff, the latter was confirmed as the most robust market efficiency model.

Table 9.2.3.2.d Correlations between mark.eff and input/output factors

		MARK.EFF			MARK.EFF
TOT.VAR	Pearson Correlation	0.125	REST.COV	Pearson Correlation	-0.183
	Sig. (2-tailed)	*0.231*		*Sig. (2-tailed)*	*0.078*
year variance	Pearson Correlation	0.072	BANQ.COV	Pearson Correlation	-0.170
	Sig. (2-tailed)	*0.495*		*Sig. (2-tailed)*	*0.102*
week variance	Pearson Correlation	0.105	BAN.REST	Pearson Correlation	-0.048
	Sig. (2-tailed)	*0.313*		*Sig. (2-tailed)*	*0.647*
repeat customers	Pearson Correlation	0.059	BANQ.TOT	Pearson Correlation	-0.057
	Sig. (2-tailed)	*0.572*		*Sig. (2-tailed)*	*0.583*
BUSINESS	Pearson Correlation	-0.012	REST.TOT	Pearson Correlation	0.057
	Sig. (2-tailed)	*0.883*		*Sig. (2-tailed)*	*0.583*
LEISURE	Pearson Correlation	-0.030	TOT.COV	Pearson Correlation	-0.187
	Sig. (2-tailed)	*0.773*		*Sig. (2-tailed)*	*0.072*
CONFEREN	Pearson Correlation	0.074	FULL.TIM	Pearson Correlation	0.069
	Sig. (2-tailed)	*0.475*		*Sig. (2-tailed)*	*0.508*
PROPERTY	Pearson Correlation	-0.033	PART.TIM	Pearson Correlation	0.100
	Sig. (2-tailed)	*0.749*		*Sig. (2-tailed)*	*0.335*
THIRD.PR	Pearson Correlation	0.045	PROP.FUL	Pearson Correlation	-0.021
	Sig. (2-tailed)	*0.66*		*Sig. (2-tailed)*	*0.838*
THRID.P	Pearson Correlation	0.022	LENGTH	Pearson Correlation	-0.059
	Sig. (2-tailed)	*0.827*		*Sig. (2-tailed)*	*0.56*
INTERNET (88units)	Pearson Correlation	0.073	TOT.SEAT	Pearson Correlation	-0.231
	Sig. (2-tailed)	*0.494*		*Sig. (2-tailed)*	*0.054*
ROOMS	Pearson Correlation	0.009	**	Correlation is significant at the 0.01 level (2-tailed).	
	Sig. (2-tailed)	*0.930*	*	Correlation is significant at the 0.05 level (2-tailed).	

9.2.3.3 Factors that determine overall hotel efficiency

Factors affecting operational efficiency

Overall, apart from the factors affecting rooms and FB division efficiency, hotel overall operational efficiency was found to be affected by the percentage of reservations from the Internet and number of part time staff. Moreover, as the following factors did not significantly correlate with efficiency score (Table 9.2.3.1.c and 9.2.3.1.d) they were not considered to significantly determine hotel overall market and operational efficiency: percentage of roomnights from repeat customers; percentage of roomnights per market segment (business, leisure, conference); percentage of reservations per distribution channel (property based, third party and Internet); length of stay; proportion of total hotel payroll for full time staff; number of full time staff; number of managers and/or head of departments; number of IT staff; number of full time staff in front office, housekeeping, FB, telephone, administration, marketing, minor operations, maintenance; front office non payroll (material and other) expenses; housekeeping expenses (payroll and non-payroll); telephone expenses (payroll and non payroll); minor operations expenses (payroll and non payroll); administration payroll expenses; marketing expenses (payroll and non payroll); maintenance expenses (payroll and non payroll); energy expenses; total expenses for IT training; and management fee expenses.

In order better to illustrate the inputs/outputs that constructed the overall hotel operational efficiency frontier the same procedure was followed as previously. In short, the following average and percentage scores of inputs/outputs were calculated for the three efficiency categories of hotels (Table 9.2.3.3.a). Percentage scores were also used in order to develop the radar plot illustrating the configuration of inputs/outputs for the three efficiency categories hotels (Figure 9.2.3.3.a).

Table 9.2.3.3.a Average and percentage scores of inputs/outputs in Tot.oper

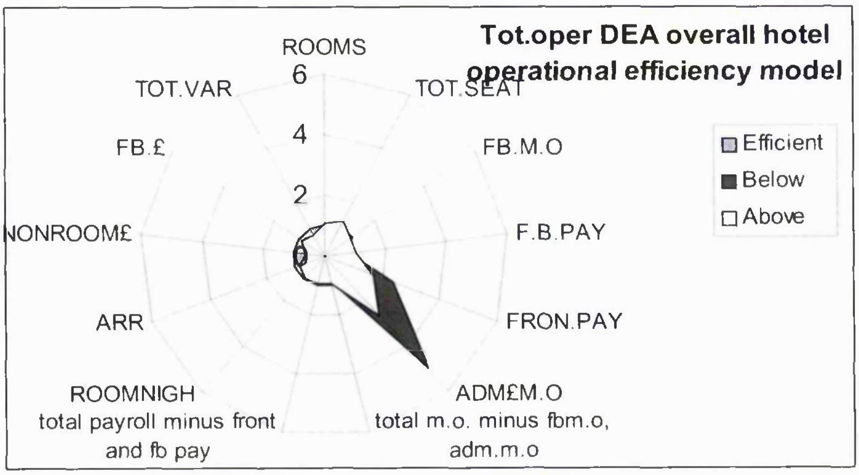
	Efficient	Below the median	Above the median	Effi cient	Below %	Above %
ROOMS	89.830	86.174	95.870	1	0.959	1.067
TOT.SEAT	270.830	306.087	355.130	1	1.130	1.311
FB.M.O	327361.936	361856.957	334507.826	1	1.105	1.022
F.B.PAY	417485.936	328922.391	436740.957	1	0.788	1.046
FRON.PAY	81574.362	195869.478	140971.348	1	2.401	1.728
ADM£M.O	52089.383	261866.696	141188.696	1	5.027	2.711
total m.o. minus fbm.o, adm.m.o	454383.511	392471.652	431697.261	1	0.864	0.950
total payroll minus front and fb pay	393793.894	359285.087	352050.870	1	0.912	0.894
ROOMNIGH	24894.383	19357.870	24006.000	1	0.778	0.964
ARR	63.644	50.652	56.001	1	0.796	0.880
NONROOM£	321300.938	110278.858	210518.508	1	0.343	0.655
FB.£	1582275.932	986268.304	1479738.583	1	0.623	0.935
TOT.VAR	3.851	2.826	3.087	1	0.734	0.802

Inefficient hotels below the media have 96% of the room and 113% and FB capacity of efficient hotels but they achieve only the 78% of roomnights, 80% of ARR, 34% of non-room revenue and 62% of the FB revenue of the efficient hotels. It is so evident that inefficient hotels significantly underuse their capacity, and particularly their FB capacity. Moreover, inefficient hotels below the media spend 10% more FB non-payroll expenses than efficient hotels and 79% of the payroll of efficient hotels in order to achieve the 62% of efficient hotels revenue (overspend of FB resources). As concerns, the rooms division inefficient hotels below the median spend 240% of the front office payroll and 503% of the administration non payroll expenses of efficient hotels and achieve only the 78% of the efficient hotels roomnights (overspend of rooms division resources). Overspend in other expenses is also evident as inefficient hotels spend the 86% of efficient hotels other non-payroll expenses and the 91% of the efficient hotels other payroll expenses although they achieve lower FB revenue and roomnights than the efficient hotels.

Inefficient hotels above the media are doing better than inefficient hotels below the media both in terms of resource utilisation and expense control. Inefficient hotels above the media have approximately the same room capacity and the 130% FB capacity of efficient hotels but they achieve only the 96% of roomnights, the 88% of ARR, the 65% of the non-room revenue and the 93% of FB revenue of efficient hotels. Efficient hotels above the media are doing quite well in terms of managing their FB expenses, they have very similar FB expenses but they achieve a slightly lower FB revenue. As concerns, rooms division expenses inefficient hotels above the media significantly overspend in terms of front office and administration expenses but less than inefficient below the media do, i.e. 172% of efficient hotels' front office payroll and 270% of the efficient hotels' administration non-payroll expenses in comparison to the 240% and 502% of the inefficient hotels below the median. It is also evident that inefficient hotels above the media are controlling their other expenses approximately as ell as efficient units.

These findings are better illustrated into the following radar plot efficiency frontier figure (Figure 9.2.3.3.a). The latter clearly illustrates the significant effect of administration non-payroll expenses and front office payroll in the overall hotel operational efficiency. The efficiency frontier of the efficient units, which lies out of the border area of the other two efficient frontiers, also indicates that ARR, roomnights, FB revenue and non-room revenue also affect efficiency.

Figure 9.2.3.3.a Configuration of inputs/outputs in Tot.oper DEA overall hotel operational efficiency model



However, the hotels in the three efficient clusters based on the Tot.oper model differed significantly in their variability score, which is also shown in the significant correlation between tot.oper and business variability. That meant that some of the operational inefficiency is due to the variability of business. However, as it was not possible to construct another DEA model including this additional factor, a market efficiency DEA model (mark.eff) was constructed in order to identify hotels that were market efficient only.

Factors affecting market efficiency

As previously analysed, the score mark.eff measured the market efficiency in the overall hotel property. Apart from the scale of operation and business variability that were found to affect market efficiency, the following factors were not found to affect market efficiency (no significant correlations, Table 9.2.3.2.d), although they could have done so: roomnights per market segment (business, leisure and conference); the percentage allocation of reservations per distribution channel (property based, third party and Internet); length of stay; relationship between restaurant and banqueting covers; full time and part tie employees; and the percentage of total hotel payroll to full time staff.

9.2.3.4 Distinguishing hotel overall operational from market efficiency

An operational - market hotel overall efficiency matrix was constructed in order to distinguish operational from market efficient hotels (Table 9.2.3.4.a). Operational efficiency was found from the tot.oper DEA model, while the market efficiency was given by the mark.eff DEA model. Hotels that were efficient in the mark.eff model but inefficient in Tot.oper were placed in cluster 3, hotels that were inefficient in mark.eff but efficient in Tot.oper were placed in cluster 2, hotels that were efficient in both models were placed in cluster 4 and hotels that were inefficient in both models were placed in cluster 1.

Table 9.2.3.4.a Operational – Market hotel overall efficiency matrix

Market efficiency			
	Efficient (In mark.eff)	**Cluster 3** *Units:* 1 *Variability score:* 1.0	**Cluster 4** *Units:* 5 *Variability score:* Min=1 Max= 6 Aver.=3.8 St.dev= 1.7
	Inefficient (In mark.eff)	**Cluster 1** *Units:* 45 *Variability score:* Min=1 Max= 6 Aver.=3.0 St.dev=1.6	**Cluster 2** *Units:* 42 *Variability score:* Min=2 Max= 9 Aver.=3.8 St.dev=2.06
		Inefficient (In Tot.oper)	Efficient (In Tot.oper)
		Operational efficiency	

Clusters 3 + 4 = Market efficient units
Clusters 2 + 4 = Operational efficient units

It is evident from Table 9.2.3.4.a, that most of the hotels that are market efficient are also operational efficient (5 out of 6 units). The one unit that is only market efficient has the lowest variability score (1= business greatly fluctuates both per week and per year) meaning that its market efficiency is due to the fact that it can successfully manage the very unfavourable market circumstances within which it operates. The operational efficiency score for that unit is 84.21%, meaning that it is an inefficient unit and so it needs to try to improve operational efficiency. Units that are both market and operational efficient face less business variability than operational efficient only hotels, (the former have a small standard deviation in their business variability score) and much less variability from inefficient hotels. This illustrates that hotels in category four are actually considered both market and operational efficient because they can achieve better results despite the unfavourable conditions that they face. Hotels in cluster two need to take actions to better manage business variability and increase their market efficiency, while hotels in cluster one need to enhance both operational and market efficiency.

9.3 Impact of demographics on hotel productivity

Seven factors namely location, hotel design, ownership structure, management arrangement, market segments served by the hotel as well as types of distribution channels of hotel reservations were investigated in order to identify whether they had any effect on market, operational and combined efficiency in rooms and FB division as well as in the overall hotel property. To that end parametric tests (and when necessary non-parametric tests) were conducted in order to investigate whether hotels clustered in different types significantly differed in their efficiency scores. Moreover, since the raw efficiency scores were available for operational and combined efficiency in rooms division, combined efficiency in FB and operational and market efficiency in overall hotel property, ANOVA and t-tests were conducted. On the contrary, as for market efficiency in rooms divisions the raw efficiency scores were not available but hotels were categorised as either market efficient or market inefficient chi-square tests had to be conducted. Tests' results are reported below.

9.3.1 Productivity impact of the location of the hotel

Hotels were clustered in three categories of hotel locations namely rural, city centre and suburban situated hotels. Thus, an ANOVA test was conducted in order to investigate whether hotels clustered within these categories significantly differed in their efficiency scores. Because the assumption of the equality of variance is violated in Room 4 and Tot.oper. and because the groups are also of an unequal size the following non-parametric tests (Kruskal – Wallis tests) are also conducted. A chi-square also tested whether location had any effect in market efficiency in rooms division. Tests results are given in Appendix E.1.

Location was not found significantly to affect operational, market and combined efficiency either in rooms, FB division or in the overall hotel property. Since these findings were surprising the fact whether the productivity effect was already taken into consideration in the measurement of efficiency was investigated. To that end, an ANOVA test was conducted in order to investigate whether hotel location significantly related with business variability (which was included into productivity measurement). As business variability was significantly affected by location (i.e. hotels located in rural places faced higher fluctuations in business than hotels in city centers, Table 9.3.1.a), it can be argued that the effect of location on efficiency is incorporated into business variability and so, also taken into account through the inclusion of business variability factor into the measurement of the market and combined efficiency.

Table 9.3.1.a Results of ANOVA test: did hotels in different locations significantly differ in their business variability score?

Descriptive								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
rural	32	4.1563	1.74336	.30819	3.5277	4.7848	1.00	6.00
city centre	37	2.7568	1.62285	.26679	2.2157	3.2978	1.00	6.00
suburban	24	3.4167	2.10417	.42951	2.5282	4.3052	1.00	9.00
Total	93	3.4086	1.87800	.19474	3.0218	3.7954	1.00	9.00

Test of Homogeneity of Variances, TOT.VAR

Levene Statistic	df1	df2	Sig.
.971	2	90	.383

ANOVA, TOT.VAR

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33.610	2	16.805	5.200	.007
Within Groups	290.863	90	3.232		
Total	324.473	92			

Multiple Comparisons- Scheffe

		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
(I) location	(J) location				Lower Bound	Upper Bound
rural	city centre	1.3995*	.43398	.007	.3193	2.4797
	suburban	.7396	.48544	.318	-.4687	1.9479
city centre	rural	-1.3995*	.43398	.007	-2.4797	-.3193
	suburban	-.6599	.47117	.379	-1.8327	.5129
suburban	rural	-.7396	.48544	.318	-1.9479	.4687
	city centre	.6599	.47117	.379	-.5129	1.8327

* The mean difference is significant at the .05 level.

9.3.2 Productivity impact of the design of the hotel

Hotels were clustered in three categories of hotel design namely old and/or traditional, redesigned/converted and purpose built hotels. Thus, an ANOVA test was conducted in order to investigate whether hotels clustered within these categories significantly differed in their efficiency scores. Because the assumption of the equality of variance is violated in Room 4 and Tot.oper. and because the groups are also of an unequal size the following non-parametric tests (Kruskal – Wallis tests) are also conducted. A chi-square also tested whether hotel design had any effect in market efficiency in rooms division. Tests results are given in Appendix E.2.

Hotel design significantly affected hotel overall operational but not market efficiency as well as Rooms division operational, market and combined efficiency. Specifically, according to the Scheffe post hoc tests, purpose build hotels had a significantly higher operational efficiency in rooms division as well as in hotel overall from old and/or traditional hotels and redesigned/converted hotels. Purpose built hotels also had a significantly higher combined efficiency in rooms division than traditional and/or old hotels as well as the former were more likely to be market efficient in rooms division than the other two categories. Moreover, although old and/or traditional hotels had the lower FB efficiency, this difference was not found as statistically significant.

9.3.3 Productivity impact of hotel ownership

Hotels were identified either as independently or as chain owned and so, a two-tailed t-test (at a significant level of 0.05) was conducted in order to investigate whether these two different types of hotels significantly differed in their efficiency scores. Because the assumption of the equality of variance is violated in Room 4 and Tot.oper. and because the groups are also of an unequal size the following non-parametric tests (Mann-Whitney tests) are also conducted. A chi-square also tested whether hotel ownership had any effect in market efficiency in rooms division. Tests results are given in Appendix E.3.

In the rooms division, ownership structure was found significantly to affect only the combined efficiency in Rooms division, as chain owned hotels had a significantly higher efficiency score from independent owned hotels. Hotel ownership also significantly affected efficiency in FB division; again chain owned hotels had a significantly higher FB efficiency score. As concerns, overall hotel property efficiency, ownership structure significantly affected both operational and market hotel overall efficiency, with the chain hotels again being more efficient than independent owned hotels.

The significant effect of ownership structure and hotel design on efficiency is understood when considering the fact that most purpose built hotels (and as found the more efficient hotels) are chain owned, while most of the old/traditional hotels (and less efficient) are independently owned. Indeed, as cross-tabulations in Table 9.3.3.a illustrate the relationship between ownership structure and hotel design is statistically significant.

Table 9.3.3.a Relationship between hotel ownership and design

			Design			Total
			old and/or traditional	redesigned/ converted	purpose built	
ownership	independently owned	Count	21	14	13	48
		Expected Count	16.0	12.9	19.1	48.0
		% within Design	67.7%	56.0%	35.1%	51.6%
		Std. Residual	1.3	.3	-1.4	
	chained owned	Count	10	11	24	45
		Expected Count	15.0	12.1	17.9	45.0
		% within Design	32.3%	44.0%	64.9%	48.4%
		Std. Residual	-1.3	-.3	1.4	
Total		Count	31	25	37	93
		Expected Count	31.0	25.0	37.0	93.0
		% within Design	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.444	2	.024
Likelihood Ratio	7.574	2	.023
Linear-by-Linear Association	7.214	1	.007
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.10.

9.3.4 Productivity impact of management arrangement

Hotels were clustered into three categories of management arrangement namely independent management, chain management and independent management and hotel consortia membership hotels. Thus, an ANOVA test was conducted in order to investigate whether hotels clustered within these categories significantly differed in their efficiency scores. Assumptions regarding equality of variances and size of samples were not simultaneously violated and so, there was no need to do any non-parametric tests. A chi-square also tested whether hotel design had any effect in market efficiency in rooms division. Tests' results are given in Appendix E.4.

Management arrangement was found to significantly affect combined efficiency in rooms division and efficiency in the FB division. Specifically, post hoc Scheffe tests illustrated that chain managed hotels had significantly higher efficiency cores.

9.3.5 Productivity impact of market segments served and distribution channels used

The percentage of roomnights attributed to business, leisure, conference and repeat guests as well s the percentage of reservations taken from property based system, third parties and Internet were provided. Thus, in order to test whether the type of market segment served and use of distribution channel affected efficiency correlations between efficiency scores and roomnights and reservations were investigated. Actually, these statistics were previously computed in the stepwise approach, which also indicated that market segment served and distribution channel used was not a productivity determinant factor.

However, because the raw efficiency scores of market efficiency in rooms division could not be calculated, two-tailed t-tests (at a significant level of 0.05) instead of Pearson correlations were used in order to test whether market efficient hotels significantly differ in the percentage of roomnights served by market segment as well as in the percentage of reservations taken by distribution channel. T-tests' results are given in Appendix E.5. T-tests again revealed that market segment served as well as type of distribution channels of hotel reservations did not significantly impacted on rooms division market efficiency. However, because the assumption of equality of variances was not validated for repeat customers as well as because sample sizes were also unequal the Mann – Whitney test was conducted, which again confirmed that the percentage of roomnights coming from repeat customers does not significantly affect market efficiency in rooms division.

Overall, market segment served was not found to affect efficiency, but this might be quite surprising. However, the market segment served might have a significant effect on business fluctuations and so the business variability score, for whose effect on efficiency is already taken into account in the market efficiency metric. Therefore, if this is the case, then the effect of market segments on efficiency is already calculated through the incorporation of the business variability score in the DEA model. In order to investigate this possibility, the correlations between the percentage of roomnights for business and leisure guests and business variability were calculated (Table 9.3.5.a). However, no significant correlation was found between market segment served and business variability score and so it was concluded that market segment served could not have impacted on efficiency.

Table 9.3.5.a Correlations

		BUSINESS	LEISURE	TOT.VAR
TOT.VAR	Pearson Correlation	-.064	.057	1
	Sig. (2-tailed)	*.542*	*.590*	.

** Correlation is significant at the 0.01 level (2-tailed).

9.3.6 Productivity impact of hotel revenue orientation

Hotels were classified into two groups, i.e. hotels getting more revenue from rooms division and hotels getting more revenue from FB. Thus, a two-tailed t-test (at a significant level of 0.05) was conducted in order to investigate whether hotels from these two categories significantly differ in their efficiency scores. As the assumption of equality of variance was not validated for Rooms 4 and as the size of samples was also unequal the Mann Whitney U non-parametric test was conducted, which again revealed that revenue orientation does not affect Rooms 4. Tests' results are given on Appendix E.6.

It was found that hotels getting more revenue from rooms have a higher combined rooms division efficiency score than those that get more revenue from FB, while hotels that get more revenue from FB have a higher FB efficiency score. Although revenue orientation affected efficiency in individual divisions, it was not found to affect efficiency in the hotel property overall.

9.3.7 Summary of the productivity impact of demographic features

Table 9.3.7.a summarises the findings regarding the impact of demographic variables on efficiency per hotel division and per type of productivity. Overall, only four factors were found to significantly affect productivity namely hotel design, ownership structure and management arrangement and revenue orientation. Hotel location was also claimed to affect productivity but its impact was already taken into consideration when measuring productivity and so, significant differences among hotels in different locations were not found.

Table 9.3.7.a Effect of demographics on efficiency

	Rooms division			FB	Hotel overall		
	Oper.	**Mark.**	**Comb.**	**Comb.**	**Oper.**	**Mark.**	**Comb.**
Location							
Hotel design	*	*	*		*		
Ownership structure			*	*	*	*	
Management arrangement			*	*			
% of roominghts from market segments							
% of roominghts from repeat customers							
% of reservations per distribution channel							
Revenue orientation			*	*			

A more detailed insight into the productivity effect of demographics on the different types of productivity can be taken when the demographic profile of hotels that are found in different clusters in the operational – market efficiency matrices are given.

Table 9.3.7.b illustrates the distribution of demographic features per efficiency cluster in the operational – market matrix for the rooms division. The given percentages are calculated within each cluster and illustrate the effect of each feature on efficiency in rooms division. Unfortunately, chi-square tests could not be conducted in order to statistically test the impact of demographic variables on the classification of hotels in the operational – market matrix (there were only two units in cluster 2).

Table 9.3.7.b Demographics of hotels per cluster in the operational-market efficient matrix in the rooms division

Market efficiency	Inefficient (In Room 3)		Efficient (In Room 3)	
Efficient **(In Room 4)**	**Cluster 3**		**Cluster 4**	
	Units: 19		*Units:* 14	
	old and/or traditional	21.05263	old and/or traditional	14.28571
	redesigned/converted	21.05263	redesigned/converted	21.42857
	purpose built	57.89474	purpose built	64.28571
	independently owned	52.63158	independently owned	42.85714
	chained owned	47.36842	chained owned	57.14286
	indep. Mangt	26.31579	indep. Mangt	21.42857
	chain mangt	47.36842	chain mangt	57.14286
	indep. Mangnt + consortia membership	26.31579	indep. Mangnt + consortia membership	21.42857
	Business	78.94737	business	78.57143
	Leisure	21.05263	leisure	21.42857
	repeat customers	32.31579	repeat customers	46.07143
	TOT.VAR	1.736842	TOT.VAR	4.5
Inefficient **(In Room 4)**	**Cluster 1**		**Cluster 2**	
	Units: 58		*Units:* 2	
	old and/or traditional	43.1034	old and/or traditional	0
	redesigned/converted	29.3103	redesigned/converted	50
	purpose built	27.5862	purpose built	50
	independently owned	55.1724	independently owned	0
	chained owned	44.8276	chained owned	100
	indep. Mangt	34.4828	indep. Mangt	0
	chain mangt	48.2759	chain mangt	100
	indep. Mangnt + consortia membership	17.2414	indep. Mangnt + consortia membership	0
	Business	62.069	business	100
	Leisure	37.931	leisure	0
	repeat customers	35.552	repeat customers	57.5
	TOT.VAR	3.67241	TOT.VAR	4

Operational efficiency

Clusters 3 + 4 = Market efficient units
Clusters 2 + 4 = Operational efficient units

Table 9.3.7.c illustrates the distribution of demographic features per efficiency cluster in the operational – market matrix for the overall hotel property. The given percentages are calculated from within each cluster and illustrate the effect of each feature on efficiency in the property as a whole. Unfortunately, chi-square tests could

not be conducted in order to statistically test the impact of demographic variables on the classification of hotels in the operational – market matrix (there was only one unit in cluster 3 and five in cluster 4).

Table 9.3.7.c Demographics of hotels per cluster in the operational-market efficient matrix for the overall hotel property

Market efficiency	Inefficient (In Tot.oper)		Efficient (In Tot.oper)	
Efficient (In mark.eff)	**Cluster 3**		**Cluster 4**	
	Units: 1		*Units:* 5	
	old and/or traditional		old and/or traditional	20
	redesigned/converted	100	redesigned/converted	20
	purpose built		purpose built	60
	independently owned		independently owned	
	chained owned	100	chained owned	100
	indep. Mangt		indep. Mangt	
	chain mangt	100	chain mangt	100
	indep. Mangnt + consortia membership		indep. Mangnt + consortia membership	
	Business		business	60
	Leisure	100	leisure	40
	repeat customers	60	repeat customers	36.4
	TOT.VAR	1	TOT.VAR	3.8
Inefficient (In mark.eff)	**Cluster 1**		**Cluster 2**	
	Units: 45		*Units:* 42	
	old and/or traditional	42.222	old and/or traditional	26.190
	redesigned/converted	28.889	redesigned/converted	23.810
	purpose built	28.889	purpose built	50.000
	independently owned	66.667	independently owned	42.857
	chained owned	33.333	chained owned	57.143
	indep. Mangt	37.778	indep. Mangt	26.190
	chain mangt	37.778	chain mangt	57.143
	indep. Mangnt + consortia membership	24.444	indep. Mangnt + consortia membership	16.667
	Business	68.889	business	71.429
	Leisure	31.111	leisure	28.571
	repeat customers	32.756	repeat customers	40.952
	TOT.VAR	3.000	TOT.VAR	3.857

Operational efficiency

Clusters 3 + 4 = Market efficient units
Clusters 2 + 4 = Operational efficient units

The impact of demographic variables on productivity in the FB division is summarized in Table 9.3.7.d. The effect of each variable on productivity was statistically tested by conducting t-tests, ANOVA and correlations whose results are given in Appendix E.

Table 9.3.7.d Demographics of efficient and inefficient hotels in the FB division

FB efficiency			
Efficient (18 units)		Inefficient (75 units)	
old and/or traditional	22.222	old and/or traditional	36.000
redesigned/converted	38.889	redesigned/converted	24.000
purpose built	38.889	purpose built	40.000
independently owned	33.333	independently owned	56.000
chained owned	66.667	chained owned	44.000
indep. Mangt	16.667	indep. Mangt	33.333
chain mangt	66.667	chain mangt	46.667
indep. Mangnt + consortia membership	16.667	indep. Mangnt + consortia membership	20.000
business	66.667	business	69.333
leisure	33.333	leisure	30.667
Rooms	27.778	rooms	36.000
Fb	72.222	fb	64.000
repeat customers	44.667	repeat customers	35.093
TOT.VAR	3.278	TOT.VAR	3.440

9.4 ICT impact on productivity

It was argued that the way ICT investments are being measured has a crucial impact on whether a relationship between productivity and ICT investments is found. Thus, three metrics of ICT were gathered in order to investigate whether ICT have any productivity impact. Specifically, three metrics were used to measure ICT namely: a) availability of different ICT systems, measured as the total number of ICT as well as the number of available ICT in particular ICT clusters; b) the integration of available ICT with the PMS (the digital nervous system of the hotel ICT infrastructure) as well as ICT system integration with other systems; c) sophistication of use of ICT. These constructs of ICT investments were argued to reflect the major features and capabilities of ICT that literature and research has indicated to significantly affect productivity.

In order to test the impact of these three constructs on different types of productivity in terms unit of analysis (three levels i.e. hotel overall, hotel divisions and individual input and output factors) and in terms of productivity nature (i.e. operational, market and combined efficiency) the following tests were conducted.

9.4.1 The impact of single ICT availability on productivity

The productivity effect of the availability of single ICT was investigated by conducting the following statistical tests:

- Two-tailed t-tests (at a significant level of 0.05) and Mann Whitney U tests (in cases where the assumption of equality of variance and size of sample were simultaneously violated) for investigating the effect of ICT availability on operational efficiency in rooms division (Rooms 3), combined efficiency in rooms division (Rooms 4), combined efficiency in FB (FB4) and operational (tot.oper) and market efficiency in the overall hotel property. T-tests could be conducted since the raw efficiency scores were available for all 93 units. The results of the tests are given in Appendix F.1.1.

- Chi-Square tests for investigating the effect of ICT availability on market efficiency in rooms division. Chi-Square tests had to be used as the raw market efficiency scores were not available and units were identified either as market efficient or inefficient. Results of the tests are provided in Appendix F.1.2.
- For ICT whose availability was found to have a significant effect on efficiency, the configuration of inputs/outputs (that were found to determine efficiency, see sections 9.2.2.2, 9.2.1.2 and 9.2.3.3) of two groups, i.e. hotels having these ICT and hotels that did not have them, was calculated and compared (by computing a percentage ratio) in order to identify the specific inputs/outputs on which ICT availability had an impact. Since productivity metrics were calculated in a way that considered and incorporated the effect of other factors on efficiency (e.g. business variability, market segment served etc), it is clear than any differences in the configuration of efficiency determining inputs/output between the two groups are due to the availability or not of the ICT.

By examining efficiency scores of hotels with and without ICT (Appendix F.1), it is clear that hotels with ICT had a higher efficiency score from those that did not have it; however, an exception is found in the in-room ICT namely, in-room Internet & e-mail access, whereby hotels not offering this facility were found to have a higher rooms division operational efficiency score and a similar total hotel operational efficiency score with hotels providing this in-room amenity. However, the majority of these differences between ICT holders and non-holders were not found to be statistically significant. A summary of the statistical tests investigating the impact of ICT availability (Appendix F.1) is provided in Table 9.4.1.a, whereby ICT whose availability was found to have a statistically significant impact on efficiency metrics are indicated with an asterisk.

Overall, it was found that ICT availability made a considerably more significant contribution on operational and combined efficiency rather than on market efficiency. Indeed, the availability of only three ICT namely Intranet, GDS and F&B systems had a significant effect on market efficiency per se. A more detailed analysis of the effect of ICT availability per type of productivity and hotel department is provided below.

Table 9.4.1.a The impact of the availability of single ICT on efficiency

	Rooms division			**FB**	**Overall**	
	Oper. Rooms3 (t-test)	**Market** Cl. 3+4 (Cros.tab)	**Comb.** Rooms 4 (t-test)	**Comb.** FB4 (t-test)	**Oper.** Tot.oper (t-test)	**Market** Mark.eff (t-test)
PMS	*				*	
Website	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Email	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Intranet		*				
Extranet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Customer Database/Warehouse	*					
YM					*	
GDS						*
Central Reservation System						
Property based Reservation System	*					
Marketing and Sales Systems						
Front Office System	*					
Smart Cards	n.a.		n.a.	n.a.	n.a.	n.a.
Telephone System						
Check in/out kiosks						
HRM system						
F&A system	*				*	
Decision Support Systems	n.a.		n.a.	n.a.	n.a.	n.a.
Management or Executive Systems					*	
Conf & Banq Systems	*				*	
F&B Systems					*	*
Stock & Inventory Systems	*		*		*	
EPOS	*		*		*	
Automated mini bars				*		
In room offices facilities						
TV based services						
Voice mail						
On demand movies/games			*			
In room Internet/e-mail access			*			
e-procurement system						
Electronic lock system					*	
Energy Management System					*	
Videoconferencing Systems				*	*	

An ICT effect cannot be theoretically based

n.a. only a small number of units (less than 5) had (not) the technology

9.4.1.1 Rooms Division

As regards the type of ICT significantly affecting productivity metrics in rooms division the following were found. The availability of six ICT was found significantly to affect operational efficiency namely, PMS, Customer Database, Property based reservation system, Front Office system, Finance & Accounting systems, Stock & Inventory systems. On the contrary, availability of any single distribution, reservation or in-room ICT did not significantly impact either on operational or market efficiency. The availability of an Intranet significantly affected market efficiency, while the availability of Stock & Inventory systems, in-room Internet & e-mail access and on-demand movies significantly affected combined efficiency.

In order to identify the specific productivity inputs and outputs on which these ICT can significantly affect an input/output configuration analysis was conducted (in a similar procedure as in productivity measurement section) between ICT users and non-users. Because productivity was measured in a way to incorporate the impact of multiple factors, any differences in configurations between the two groups can be attributed to ICT availability or not. Results of this analysis for each ICT found to significantly affect productivity are provided below.

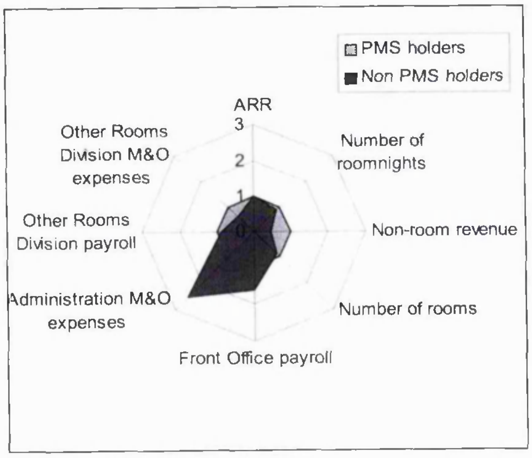
Operational efficiency

PMS availability significantly affected operational efficiency and so, for investigating its effect on specific inputs/outputs, the configuration of the inputs/outputs determining operational efficiency for both PMS and non-PMS holders were calculated (Table 9.4.1.1.a and Figure 9.4.1.1.a). The two groups achieve a similar ARR and number of roomnights, the 82.78% of roomnights is expected due to the smaller room capacity, i.e. 87.73%. PMS users though could much better control their Front Office payroll expenses and Administration M&O expenses, since non-PMS users spend the 158% of payroll and 249% of M&O expenses of PMS users, even despite their smaller room capacity (i.e. 87.73%). Non-PMS users also achieved only the 46% of the non-room revenue of PMS users, which however may be partly due to their smaller size and so the lack of minor operation activities. Other expenses (both payroll and M&O) of non-PMS users are found at expected levels, considering their smaller size and achieved level of business (lower non-room revenue, minor operations, and so lower than expected M&O expenses). The business variability score was calculated for both groups in order to investigate whether operational efficiency differences were due to market factors. As the two groups did not also differ in their environmental conditions, the effect of PMS can be attributed on Front Office payroll and Administration M&O expenses as well as on better management of the complexity and managerial issues of minor operations.

Table 9.4.1.1.a Configuration of operational efficiency determining inputs/outputs for PMS holders and non-holders

PMS	Yes (78)	No (15)	Ratio No/Yes
ARR	58.5509	58.49	0.998960
Number of roomnights	23971.04	19844.27	0.827843
Non-room revenue	264472.4	123375.9	0.466498
Number of rooms	92.24359	80.93333	0.877387
Front Office payroll	113785.3	180405.3	1.585489
Administration M&O expenses	101469.1	253592.1	2.499204
Other Rooms Division payroll	327187.1	281475	0.860288
Other Rooms Division M&O expenses	221882.3	137663.1	0.620433
Total business variability	3.432516	3.378615	0.984297

Figure 9.4.1.1.a Effect of PMS availability on inputs/outputs determining operational efficiency

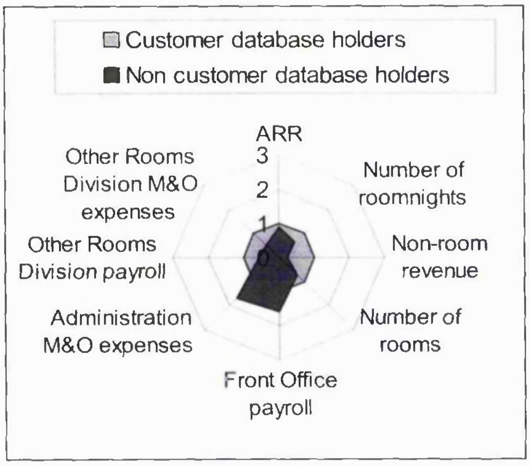


Availability of customer database also significantly affected operational efficiency. Analysis of the configuration of the efficiency determining inputs/outputs for customer database holders and non holders (Table 9.4.1.1.b and Figure 9.4.1.1.b) revealed that the latter although of a smaller room capacity (70%) they achieved proportionally lower level of roomnights, Non-room revenue, ARR and spent nearly double the amount in Front Office payroll and Administration M&O expenses. Since the two groups faced similar environmental conditions (variability score) efficiency differences can be attributed to the customer database availability.

Table 9.4.1.1.b Configuration of operational efficiency determining inputs/outputs for customer database holders and non holders

Customer database	Yes (67)	No (26)	Ratio No/Yes
ARR	60.28761	54.04038	0.896376
Number of roomnights	26027.22	16291.58	0.625944
Non-room revenue	308936.2	68490.82	0.221699
Number of rooms	98.65672	69.19231	0.701344
Front Office payroll	106746.7	170357.8	1.595907
Administration M&O expenses	105884.5	177854.5	1.679703
Other Rooms Division payroll	365049.5	203246.1	0.556763
Other Rooms Division M&O expenses	240096.3	129160.3	0.537952
Total business variability	3.41791	3.384615	0.990259

Figure 9.4.1.1.b Effect of customer database availability on the inputs/outputs determining Operational efficiency



By a similar analysis, the productivity impact of PBRS (Table 9.4.1.1.c and Figure 9.4.1.1.c) and Stock & Inventory systems (Table 9.4.1.1.d and Figure 9.4.1.1.d) was found to be on Front Office payroll and Administration M&O expenses, while the effect of Front Office (Table 9.4.1.1.f and Figure 9.4.1.1.f) and F&A systems (Table 9.4.1.1.e and Figure 9.4.1.1.e) in operational efficiency was focused on Front Office payroll.

Table 9.4.1.1.c Configuration of operational efficiency determining inputs/outputs for PBRS holders and non-holders

PBRS	Yes (70)	No (23)	Ratio No/Yes
ARR	58.622143	58.29435	0.994408341
Number of roomnights	24440.471	19850.96	0.812216597
Non-room revenue	279045.44	128100.1	0.459065406
Number of rooms	92.114286	85.26087	0.92559877
Front Office payroll	112172.23	162142.5	1.445478295
Administration M&O expenses	110647.61	172745.3	1.561220325
Other Rooms Division payroll	322699.67	311032.2	0.963844099
Other Rooms Division M&O expenses	213681.53	190489.4	0.891463998
Total business variability	3.1236761	3.253421	1.041536

Figure 9.4.1.1.c Effect of PBRS availability on the inputs/outputs determining Operational efficiency

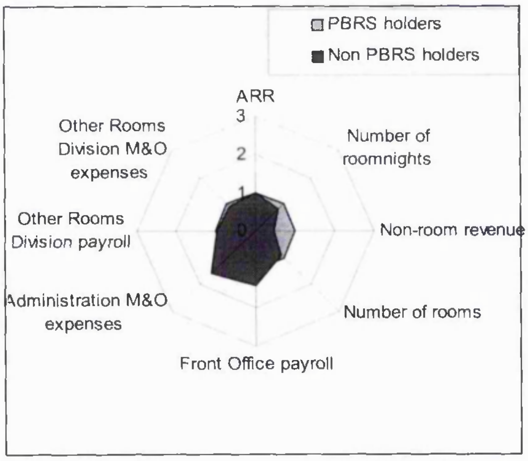


Table 9.4.1.1.d Configuration of operational efficiency determining inputs/outputs for Stock & Inventory systems holders and non-holders

Stock & Inventory systems	Yes (48)	No 45	Ratio No/Yes
ARR	58.88688	58.172222	0.987864
Number of roomnights	29802.1	16375.644	0.5494795
Non-room revenue	373274.5	101384.65	0.2716089
Number of rooms	115.3125	63.866667	0.5538573
Front Office payroll	114717.9	134997.22	1.1767756
Administration M&O expenses	118909.1	133574.13	1.1233293
Other Rooms Division payroll	411185.9	222350.98	0.5407554
Other Rooms Division M&O expenses	288353.6	128815.09	0.4467261
Total business variability	3.395833	3.4222222	1.007771

Figure 9.4.1.1.d Effect of the availability of Stock & Inventory systems on the inputs/outputs determining Operational efficiency

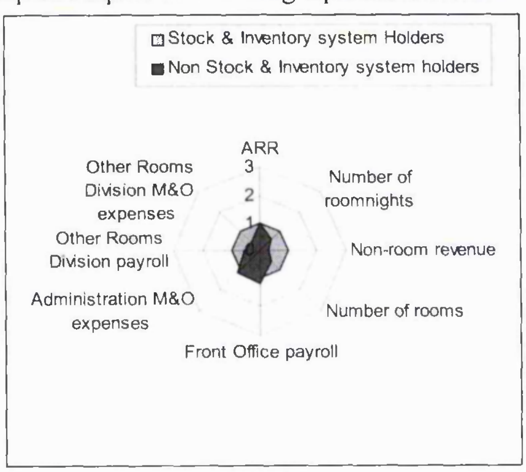


Table 9.4.1.1.e Configuration of operational efficiency determining inputs/outputs for F&A systems holders and non-holders

F&A systems	Yes (73)	No (20)	Ratio Yes/No
ARR	56.882055	64.5965	1.135622
Number of roomnights	26153.014	12911.75	0.4937
Non-room revenue	287873.75	73235	0.2544
Number of rooms	100.67123	53	0.526466
Front Office payroll	119471.51	142995.7	1.196902
Administration M&O expenses	127315.27	121223	0.952148
Other Rooms Division payroll	353024.34	198597	0.562559
Other Rooms Division M&O expenses	238885.03	100058.5	0.418856
Total business variability	3.452055	3.25	0.941468

Figure 9.4.1.1.e Effect of F&A systems availability on the inputs/outputs determining Operational efficiency

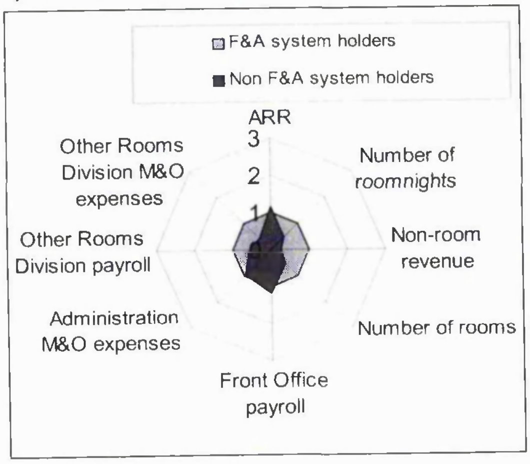
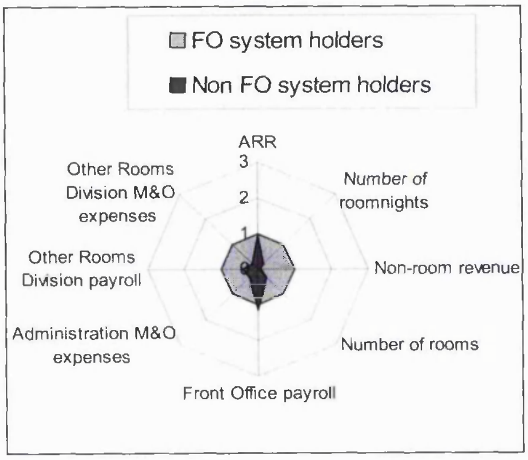


Table 9.4.1.1.f Configuration of operational efficiency determining inputs/outputs for FO system holders and non-holders

Front Office System	Yes (86)	No (7)	Ratio Yes/No
ARR	58.702558	56.557143	0.963453
Number of roomnights	24715.756	5978.5714	0.241893
Non-room revenue	259643.02	21454.857	0.082632
Number of rooms	95.348837	29.857143	0.313136
Front Office payroll	123236.4	142428.6	1.155734
Administration M&O expenses	133063.66	39285.714	0.29524
Other Rooms Division payroll	334761.83	136171.43	0.406771
Other Rooms Division M&O expenses	221640.7	44242.857	0.199615
Total business variability	3.430233	3.242857	0.945375

Figure 9.4.1.1.f Effect of FO system availability on the inputs/outputs determining Operational efficiency



One could argue that the impact that FO and PBRS have on productivity may be confounded by the fact that FO or PBRS users handle a different number of reservations coming from different than non-FO or PBRS users. However, the productivity analysis has revealed that the configuration of reservations amongst distribution channels did not determine efficiency (no significant correlations between percentage of reservations coming from distribution channels and efficiency scores). Thus, even if FO or PBRS users significantly differ in their reservations configuration, the latter could not be concluded as the reason for efficiency differences between ICT users and non-users. However, in order to investigate whether the configuration of reservations can significantly affect the type of ICT that is adopted, two-tailed t-Tests (at a significance level of 0.05) were conducted in order to test whether FO and PBRS holders differed from non systems holders in terms of the configuration of reservations taken from each channel (Tables 9.4.1.1.g and 9.4.1.1.h). Since, users and non-users of FO and PBRS did not significantly differ in the configuration of the reservations they receive per distribution channel, it was concluded that the adoption and use of these systems is not dependent on the configuration of reservations that hotels receive from different distribution channels.

Table 9.4.1.1.g T-test; reservation configuration between PBRS users and non-users

% of reservations coming through:	PBRS	N	Mean	Std. Deviation	Std. Error Mean
Property owned system (1)	Yes	70	70.28571	11.59353	1.385692
	No	23	66.97826	14.00363	2.91996
Third parties (2)	Yes	70	26.16714	11.4338	1.366601
	No	23	28.15217	14.07079	2.933963
Internet (3)	Yes	70	3.004286	3.38849	0.405002
	No	23	4.652174	6.014065	1.254019

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
(1)	Equal variances assumed	2.086	0.152	1.126	91.000	0.263	3.307	2.937	-2.526	9.141
	Equal variances not assumed			1.023	32.499	0.314	3.307	3.232	-3.272	9.887
(2)	Equal variances assumed	2.551	0.114	-0.681	91.000	0.497	-1.985	2.914	-7.773	3.803
	Equal variances not assumed			-0.613	32.100	0.544	-1.985	3.237	-8.577	4.607
(3)	Equal variances assumed	14.195	0.000	-1.641	91.000	0.104	-1.648	1.004	-3.642	0.346
	Equal variances not assumed			-1.250	26.736	0.222	-1.648	1.318	-4.353	1.057

Table 9.4.1.1.h T-test; reservation configuration between FO users and non-users

% of reservations coming through:	FO system	N	Mean	Std. Deviation	Std. Error Mean
Property owned system (1)	Yes	86	69.62209	12.36455	1.333303
	No	7	67.57143	11.22285	4.241839
Third parties (2)	Yes	86	26.38605	12.03421	1.297682
	No	7	30	13.22876	5
Internet (3)	Yes	86	3.49186	4.259169	0.459278
	No	7	2.428571	3.779645	1.428571

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
(1)	Equal variances assumed	0.304	0.583	0.424	91.000	0.672	2.051	4.832	-7.547	11.648
	Equal variances not assumed			0.461	7.239	0.658	2.051	4.446	-8.394	12.495
(2)	Equal variances assumed	0.000	0.991	-0.759	91.000	0.450	-3.614	4.762	-13.074	5.846
	Equal variances not assumed			-0.700	6.833	0.507	-3.614	5.166	-15.889	8.662
(3)	Equal variances assumed	0.147	0.702	0.640	91.000	0.524	1.063	1.662	-2.239	4.365
	Equal variances not assumed			0.709	7.299	0.501	1.063	1.501	-2.456	4.582

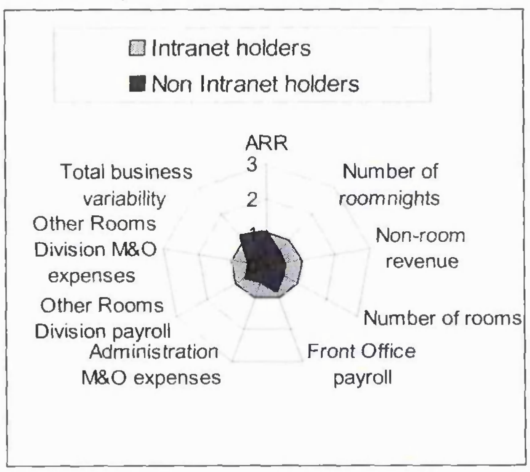
Market efficiency

Intranet availability was the only ICT that affected market efficiency in Rooms division, as a chi-square test revealed that hotels with an Intranet system could significantly better manage their rooms division operations given the level of business variability they faced. As concerns the impact of Intranet on specific inputs and outputs, statistics on the configuration of inputs/outputs of Intranet users and non users were calculated (Table 9.4.1.1.i and Figure 9.4.1.1.g). Specifically, non Intranet users had 55.69% of room capacity of Intranet users and so, the level of 56.07% of roomnights, 51.85% of non-room revenue, 52.58% of Administration M&O expenses, 68.74% of Other payroll and 52.83% of Other M&O expenses was expected. The two groups did not also differ in their achieved level of ARR, but non Intranet users spent 25.35% (81.04% - 55.69%) more Front Office payroll than Intranet users. However, Intranet holders could achieve similar levels of efficiency as non Intranet holders although facing higher business fluctuations (lower total business variability score). This in turn highlights the capability of Intranet systems to manage and control the effect of market conditions on the efficient management of rooms division operations (and specifically the control of Front Office Payroll).

Table 9.4.1.1.i Configuration of combined efficiency determining inputs/outputs for Intranet holders and non-holders

Intranet	Yes (30)	No (63)	Ratio No/Yes
ARR	56.87867	59.3327	1.043145
Number of roomnights	33178.4	18604.02	0.560727
Non-room revenue	358701.8	186006.8	0.518556
Number of rooms	129.2	71.95238	0.556907
Front Office payroll	142872	115796.4	0.810491
Administration M&O expenses	185637.9	97608.54	0.525801
Other Rooms Division payroll	405726.9	278903.3	0.687417
Other Rooms Division M&O expenses	306892	162151.8	0.528368
Total business variability	2.892314	3.555556	1.229312

Figure 9.4.1.1.g Effect of Intranet availability on controlling inputs/outputs determining Operational efficiency in unfavourable market conditions



However, this finding requires further investigation. It might be the case that the productivity impact of Intranet is not due to the availability of the system per se but because an Intranet electronic platform inherently provides systems integration and links amongst ICT in different hotel departments, whereas in the case of a PMS electronic platform this is not automatically true specifically when ICT investments have followed a piecemeal approach, which is mainly the case regarding the respondents of this study. Actually, 3 out of the 30 Intranet users did not have a PMS, which indicates that they have chosen the Intranet rather than a PMS for providing an electronic backbone to their ICT. In this vein, two-tailed t-tests were conducted for examining whether Intranet and non-Intranet users significantly differ in their ICT integration patterns (Table 9.4.1.1.j), which in turn could have affected the Intranet productivity impact. Intranet users had more of their distribution, reservation and in-room technologies integrated with their PMS than not-Intranet users, but the former also had less of their FB, general and total ICT integrated with their PMS than the latter. Although these differences were not found to be statistically significant, Intranet users had a significantly greater number of direct links amongst their ICT than non Intranet users. Therefore, it can be concluded that it is very likely that Intranet users have chosen the Intranet solution for overcoming problems in their systems integration between Rooms and FB division as well as for overcoming the overall systems integration problem, i.e. the fact that less than half (45.17%) of their ICT were PMS integrated. Moreover, the fact that Intranet users had a higher percentage of their distribution and reservation ICT integrated with their PMS than non-Intranet users may indicate that the higher market efficiency in rooms division of the former is due to their enhanced systems integration rather than their Intranet availability per se.

Table 9.4.1.1.j T-Test investigating systems integration differences between Intranet and non Intranet users

	Intranet	N	Mean	Std. Deviation	Std. Error Mean
Percentage of *distribution ICT* integrated with PMS (1)	yes	30	0.463	0.292	0.053
	no	62	0.365	0.328	0.041
Percentage of *reservation ICT* integrated with PMS (2)	yes	30	0.472	0.300	0.054
	no	62	0.424	0.355	0.045
Percentage of *in-room ICT* integrated with PMS (3)	yes	30	0.210	0.296	0.054
	no	46	0.105	0.270	0.039
Percentage of *Room Division ICT* integrated with PMS (4)	yes	30	0.577	0.361	0.065
	no	58	0.632	0.383	0.050
Percentage of *FB division ICT* integrated with PMS (5)	yes	29	0.431	0.420	0.078
	no	50	0.510	0.466	0.063
Percentage of *non FB division ICT* integrated with PMS (6)	yes	30	0.342	0.216	0.039
	no	63	0.335	0.231	0.029
Percentage of *general ICT* integrated with PMS (9)	yes	29	0.527	0.398	0.073
	no	50	0.573	0.448	0.063
Percentage of *total ICT* integrated with PMS (7)	yes	30	0.451	0.284	0.051
	no	60	0.499	0.304	0.039
Total number of *direct integrations amongst ICT (10)*	yes	30	2.500	3.830	0.699
	no	63	0.301	0.891	0.112

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
(1)	Equal variances assumed	1.193	0.278	1.398	90.000	0.166	0.099	0.071	-0.042	0.239
	Equal variances not assumed			1.455	63.822	0.150	0.099	0.068	-0.037	0.234
(2)	Equal variances assumed	1.778	0.186	0.631	90.000	0.529	0.048	0.075	-0.102	0.197
	Equal variances not assumed			0.670	67.015	0.505	0.048	0.071	-0.094	0.189
(3)	Equal variances assumed	2.290	0.134	1.591	74.000	0.116	0.105	0.066	-0.027	0.236
	Equal variances not assumed			1.560	58.048	0.124	0.105	0.067	-0.030	0.240
(4)	Equal variances assumed	0.000	0.998	-0.648	86.000	0.519	-0.055	0.085	-0.223	0.113
	Equal variances not assumed			-0.661	61.972	0.511	-0.055	0.083	-0.221	0.111

										Continued…
(5)	Equal variances assumed	1.355	0.248	-0.751	77.000	0.455	-0.079	0.105	-0.288	0.130
	Equal variances not assumed			-0.773	63.751	0.443	-0.079	0.102	-0.283	0.125
(6)	Equal variances assumed	0.015	0.904	0.129	91.000	0.898	0.006	0.050	-0.093	0.106
	Equal variances not assumed			0.132	60.584	0.896	0.006	0.049	-0.092	0.105
(9)	Equal variances assumed	2.198	0.142	-0.455	77.000	0.650	-0.046	0.101	-0.246	0.154
	Equal variances not assumed			-0.470	64.378	0.640	-0.046	0.097	-0.240	0.149
(7)	Equal variances assumed	0.012	0.912	-0.722	88.000	0.472	-0.048	0.067	-0.181	0.084
	Equal variances not assumed			-0.740	61.877	0.462	-0.048	0.065	-0.178	0.082
(10)	Equal variances assumed	45.953	0.050	4.339	91.000	0.000	2.198	0.507	1.192	3.205
	Equal variances not assumed			3.104	30.506	0.004	2.198	0.708	0.753	3.644

Combined efficiency

Two in-room ICT namely in-room Internet & e-mail access and on-demand movies affected combined efficiency because as the inputs/output configuration (Tables 9.4.1.1.k and 9.4.1.1.l) indicated ICT users could achieve a higher ARR (hotels could probably charge a higher room rate because of these amenities); the overspend in Front Office payroll and Administration M&O expenses by hotels not offering on-demand movies cannot be attributed to this ICT availability. It is also evident that hotels with in-room Internet & email access also faced lower fluctuations in their business, meaning that they could actually attract more demand because of this. Indeed, nowadays Internet access is one of the most crucial requirements of all travellers and so hotels should provide it if they want to remain competitive.

Table 9.4.1.1.k Configuration of combined efficiency determining inputs/outputs for hotels that do and do not offer in-room Internet & E-mail access

In-room Internet & E-mail access	**Yes (28)**	**No (65)**	**Ratio No/yes**
ARR	59.845	55.979	0.935
Number of roomnights	22605.290	23607.031	1.044
Non-room revenue	253366.300	236695.790	0.934
Number of rooms	87.178	91.815	1.053
Front Office payroll	129628.400	122334.460	0.943
Administration M&O expenses	114773.900	130843.180	1.140
Other Rooms Division payroll	351774.900	306046.450	0.870
Other Rooms Division M&O expenses	229339.000	198259.440	0.864
Total business variability	4.035	3.138	0.777

Table 9.4.1.1.l Configuration of combined efficiency determining inputs/outputs for hotels that do and do not offer on demand movies

On demand movies	**Yes (26)**	**No (67)**	**Ratio No/yes**
ARR	63.989	54.426	0.850
Number of roomnights	39335.380	17084.851	0.434
Non-room revenue	408883.200	176843.590	0.432
Number of rooms	149.884	67.343	0.449
Front Office payroll	139669.30	118655.700	0.849
Administration M&O expenses	140853.80	120242.940	0.853
Other Rooms Division payroll	465942.50	263107.630	0.564
Other Rooms Division M&O expenses	365611.20	145999.330	0.399
Total business variability	3.423	3.402	0.994

Efficiency differences between hotels offering these types of in-room amenities cannot be attributed to any differences in the composition of hotel roomnights in terms of type of market segment served by these two groups, as the latter was not found to affect efficiency (section in productivity measurement analysis). However, the roomnights' composition per market segments for these two groups was investigated in order to examine whether the provision of these amenities is advisable to hotels targeting particular types of market segments.

A two-tailed t-test examining the market segments served by hotels with and without the in-room Internet access revealed that the former have more roomnights from business and conference travellers and less or similar levels of leisure travellers, but these differences were not found to be significant (Table 9.4.1.1.m). In this vein, the availability of this in-room amenity is equally important for all hotels irrespective of their market orientation.

Table 9.4.1.1.m T-Test investigating differences in market segments between in-room Internet and non – in-room Internet holders

% of roomnights from:	In-room Internet & E-mail availability	N	Mean	Std. Deviation	Std. Error Mean
BUSINESS travellers	Yes	28	46.157	21.840	4.127
	No	65	47.583	21.292	2.641
LEISURE travellers	Yes	28	36.160	18.729	3.539
	No	65	37.135	25.820	3.202
CONFERENCE travellers	Yes	28	14.089	10.913	2.062
	No	65	10.858	10.197	1.264

% of roomnights from:		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BUSINESS travellers	Equal variances assumed	0.054	0.816	-0.294	91.000	0.769	-1.426	4.850	-11.060	8.209
	Equal variances not assumed			-0.291	50.092	0.772	-1.426	4.900	-11.268	8.416
LEISURE travellers	Equal variances assumed	3.616	0.060	-0.180	91.000	0.857	-0.975	5.411	-11.723	9.773
	Equal variances not assumed			-0.204	69.622	0.839	-0.975	4.773	-10.496	8.546
CONFERENCE travellers	Equal variances assumed	0.339	0.562	1.372	91.000	0.173	3.231	2.354	-1.446	7.907
	Equal variances not assumed			1.335	48.248	0.188	3.231	2.419	-1.633	8.095

On the contrary, a t-test investigating the market segment composition between in-room on-demand movies holders and non-holders revealed that the latter had significantly more roomnights from leisure guests and less roomnights from conference guests than hotels offering this amenity (Table 9.4.1.1.n). Thus, it can be argued that the on-demand movies guest room amenity can benefit more business rather than leisure oriented hotels.

Table 9.4.1.1.n T-Test investigating differences in market segments between in-room Internet and non – in-room Internet holders

% of roomnights coming from:	On demand movies	N	Mean	Std. Deviation	Std. Error Mean
BUSINESS travellers	Yes	26	53.111	18.888	3.704
	No	67	44.841	19.927	2.678
LEISURE travellers	Yes	26	25.215	13.368	2.621
	No	67	41.353	23.469	3.111
CONFERENCE travellers	Yes	26	16.669	10.787	2.115
	No	67	9.953	9.786	1.195

% of roomnights coming from:		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BUSINESS travellers	Equal variances assumed	1.892	0.172	1.693	91.000	0.049	8.270	4.884	-1.431	17.971
	Equal variances not assumed			1.809	52.544	0.046	8.270	4.571	-0.901	17.441
LEISURE travellers	Equal variances assumed	19.915	0.000	-3.064	91.000	0.003	-16.138	5.267	-26.600	-5.677
	Equal variances not assumed			-3.966	82.801	0.000	-16.138	4.069	-24.231	-8.045
CONFERENCE travellers	Equal variances assumed	1.220	0.272	2.886	91.000	0.005	6.715	2.327	2.093	11.338
	Equal variances not assumed			2.763	41.900	0.008	6.715	2.430	1.811	11.620

9.4.1.2 Food and Beverage Division

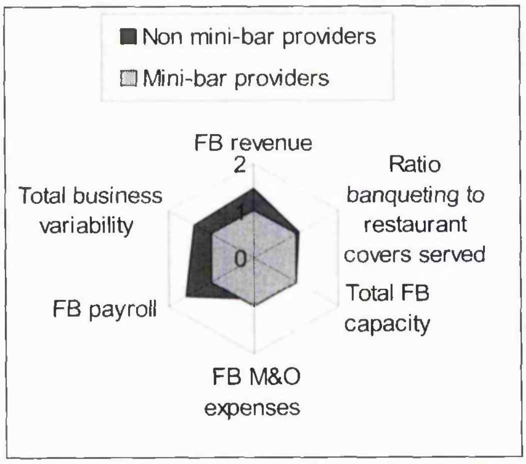
Interestingly, the availability of none of the FB ICT affected efficiency in FB division (Table 9.4.1.a). On the contrary, hotels with automated mini-bars and videoconferencing systems availability had a significantly higher FB efficiency score than hotels without such availability. The configuration of FB efficiency determining inputs/outputs for both groups was calculated in order to investigate the efficiency effect of these two ICT.

The configuration of FB determinant input/output factors for hotels providing and not providing automated mini bars is given in Table 9.4.1.2.a and Figure 9.4.1.2.a. Since the levels of the percentage of banqueting to restaurant covers served and of FB capacity were similar for both groups, efficiency differences cannot be attributed to these factors. Moreover, non-mini bar users achieved a higher FB revenue but they spent a proportionally more FB payroll to achieve that (i.e. 160% more FB payroll for 148% more FB revenue, i.e. 12% more payroll than expected); the fact that the former controlled their M&O expenses did not outweigh the inefficiencies of the undercontrol of payroll. Moreover, mini bar users faced less favourable market conditions (lower business fluctuations score) than non-mini bar users, which indicates that investments on automated mini-bars may have been done in order to overcome the high fluctuation in business and so the inefficiencies that they can cause through, e.g. slack of human resources in FB during low periods of demand.

Table 9.4.1.2.a Configuration of FB efficiency determining inputs/outputs for mini-bar providers and non providers

Automated mini-bars	Yes (7)	No (88)	Ratio No/Yes
FB revenue	1360034.300	2017454.000	1.483
Ratio banqueting to restaurant covers served	0.352	0.375	1.065
Total FB capacity	300.290	301.714	1.004
FB M&O expenses	340808.660	298979.400	0.877
FB payroll	382996.020	613491.100	1.601
Total business variability	3.313	4.571	1.379

Figure 9.4.1.2.a Effect of mini-bar availability on inputs/outputs determining FB efficiency

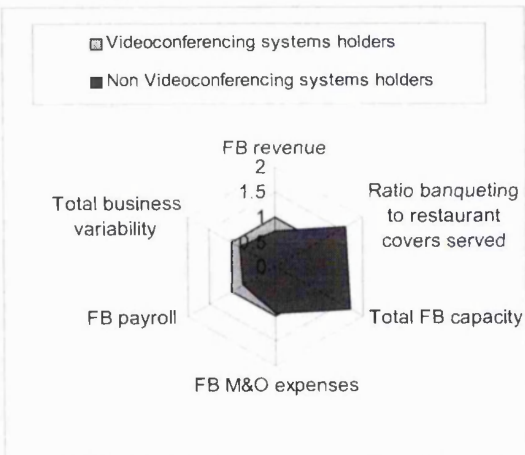


The impact of videoconferencing systems on FB efficiency is not surprising since hotels offering these facilities can attract and provide more events, e.g. meetings, conferences etc, and so get greater F&B revenue which in turn contributes to their efficiency. Indeed, the analysis of the configuration of the FB efficiency determining input/output variables for the two groups (Table 9.4.1.2.b and Figure 9.4.1.2.b) revealed that hotels without videoconferencing systems although 1.5 times of a bigger FB capacity than hotels with videoconferencing capacity only achieved a similar number of total FB covers (0.958%) and a much lower level of FB revenue (only the 0.72%) than hotels with videoconferencing. Moreover, for non-videoconferencing systems providers, FB expenses were at a reasonable level (0.94% for M&O expenses and 0.71% for payroll) when taking into account their 0.95% level of FB covers and the 72% level of FB revenue, meaning that efficiency differences cannot be attributed to differences in expenses: instead, the good control of expenses can be attributed to the fact that they offered more banqueting to restaurant covers. Thus, the higher FB efficiency of hotels with videoconferencing systems is due to their usage of FB capacity, which confirmed the fact that videoconferencing facilities were used for increasing utilisation of FB capacity. The higher variability score, i.e. lower fluctuations in business, of videoconferencing systems providers also illustrates that the systems are used as a tool for attracting business and/or alleviating problems during periods of low demand.

Table 9.4.1.2.b Configuration of FB efficiency determining inputs/outputs for videoconferencing systems providers and non providers

Videoconferencing systems	Yes (5)	No (88)	Ratio No/Yes
FB revenue	1200406	876213	0.729
Total covers served	86094	82537.6	0.958
Ratio banqueting to restaurant covers served	0.2	0.3	1.623
Total FB capacity	182	307.1	1.687
FB M&O expenses	357975.2	336506	0.940
FB payroll	550307.6	391824.5	0.712
Total business variability	3.2	2.8	0.794

Figure 9.4.1.2.b Effect of videoconferencing systems availability on inputs/outputs determining FB efficiency



9.4.1.3 Hotel property

From the 11 ICT that significantly affected efficiency in the two hotel divisions only four of them were also found to have a significant effect on the efficiency of the hotel property as a whole, namely PMS, F&A, Stock and Inventory and videoconferencing systems, whose holders accounted for higher operational efficiencies. The availability of YM, Conference & Banqueting, F&B systems, EPOS, electronic lock and Energy Management systems also contributed to higher operational efficiencies, while the availability of GDS and FB systems resulted in higher market efficiencies. The productivity impact of these ICT on specific inputs/outputs is investigated by input/output configuration statistics of ICT holders and non holders as follows. As the hotel overall DEA model is constructed by inputs/outputs that determine efficiency in rooms and FB division configuration analysis is done for both divisions.

<u>**Operational efficiency**</u>

Videoconferencing systems providers had a significantly higher operational efficiency in the overall hotel property (actually all users were found to be 100% efficient) than non-videoconferencing providers. The configuration of the efficiency determining inputs/outputs in FB division has been conducted previously (Table 9.4.1.2.b) and identified that the impact of videoconferencing systems on FB efficiency is focused on the enhancement of capacity utilisation. On the other hand, the inputs/outputs configuration in the Rooms division revealed that efficiency differences between videoconferencing providers and non-providers can be attributed to differences in ARR (Table 9.4.1.3.a). This is because roomnights could not have attributed to efficiency differences, as the achieved level of roomnights of non videoconferencing systems providers (73% of providers) is fully attributed to the level of their rooms capacity (74% of providers). Moreover, efficiency differences can also attributed to Front Office payroll and Administration M&O expenses (the level of other expenses can be explained by differences in room capacity and roomnights), but the availability of videoconferencing systems cannot be argued to have had an effect on these.

Table 9.4.1.3.a Configuration of hotel property operational efficiency determining inputs/outputs for videoconferencing systems providers and non providers

Videoconferencing systems	Yes (5)	No (88)	Ratio No/Yes
ARR	78.798	57.39	0.728
Roomnights	32556	23779.83	0.730
Non-room revenue	305400	220096.40	0.720
Number of rooms	119.4	88.772727	0.743
Front Office Payroll	107670.2	125488.44	1.165
Administration M&O expenses	61222.6	129685.93	2.118
Other Rooms division payroll expenses	552750	306579.17	0.554
Other Rooms division M&O expenses	290912.5	203771.61	0.700

An investigation of the market segments served by videoconferencing and non-videoconferencing providers also revealed that the former get statistically significant more roomnights from conference guests than the latter (Table 9.4.1.3.b), which might explain the higher ARR achieved when these systems are available.

Table 9.4.1.3.b ANOVA test investigating differences in market segments served between videoconferencing and non videoconferencing providers

% of roomnights from:	Videoconferencing systems providers (5)				Non videoconferencing systems providers (88)			
	Min	Max	Mean	St. Dev	Min	Max	Mean	St. Dev
BUSINESS travellers	5	90	47.537	21.003	0	65	40.4	28.780
LEISURE travellers	2	90	36.912	23.938	15	70	35.6	23.964
CONFERENCE travellers	0	47	11.367	10.041	5	45	20	11.411

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BUSINESS travellers	Equal variances assumed	1.706	0.195	-0.725	91.000	0.470	-7.138	9.841	-26.685	12.410
	Equal variances not assumed			-0.546	4.246	0.612	-7.138	13.064	-42.597	28.322
LEISURE travellers	Equal variances assumed	0.003	0.960	-0.119	91.000	0.905	-1.312	11.006	-23.174	20.549
	Equal variances not assumed			-0.119	4.466	0.910	-1.312	11.017	-30.682	28.057
CONFERENCE travellers	Equal variances assumed	0.502	0.480	1.817	91.000	0.043	8.633	4.752	-0.807	18.073
	Equal variances not assumed			1.238	4.195	0.051	8.633	6.975	-10.382	27.647

Moreover, all hotels with videoconferencing systems availability claimed to get more revenue from the FB division than the rooms division department (Table 9.4.1.3.c), which also confirms the effect of these systems in FB efficiency.

Table 9.4.1.3.c Revenue orientation of videoconferencing and non videoconferencing providers

Videoconferencing systems	Revenue orientation	
	Rooms division	FB division
No	32	56
Yes	0	5

As concerns the impact of PMS on hotel overall productivity the following are found. It was previously found that the effect of PMS on rooms division efficiency was mainly attributed to its capability to control Front Office payroll and Administration M&O expenses (Table 9.4.1.1.a). The configuration of FB efficiency determinant inputs/output factors for PMS and non-PMS holders was also calculated (Table 9.4.1.3.d) and which revealed that the inefficiency of non-PMS holders can be mainly attributed to their low utilisation of FB capacity (they have 120% of FB capacity of PMS holders but achieve only the 81% of the PMS holders' FB revenue). However, taking into account the achieved level of their FB revenue, non-PMS holders can somewhat control expenses as successfully as PMS holders, mainly because they serve more banqueting covers than the latter. Thus, PMS holders achieved a hotel overall operational efficiency although being of a bigger FB capacity and serving more restaurant than banqueting covers than non-PMS holders. It can so be argued that PMS availability helped hotels to manage better the increased complexity that is due to two reasons: a) bigger FB capacity; and b) increased levels of a la carte FB covers served.

Table 9.4.1.3.d Configuration of FB efficiency determining inputs/outputs PMS holders and non holders

PMS	Yes (78)	No (15)	Ratio No/Yes
FB revenue	1452297	1187064	0.817
Total covers served	0.3351649	0.453111	1.351
Ratio banqueting to restaurant covers served	290.84615	350.07	1.203
Total FB capacity	338381.55	333909.33	0.986
FB M&O expenses	408663.04	357091.93	0.873
FB payroll	3.525641	2.8	0.794
Total business variability	3.432516	3.378615	0.984

Regarding the productivity impact of YM systems, the configuration of efficiency determinant input/output in FB and rooms divisions between YM holders and non holders is given in Table 9.4.1.3.e. Non-YM holders have 112% FB capacity of YM holders but achieve only the 87% of the FB revenue of YM holders. The underutilisation of FB capacity by non-YM holders has so substantially contributed to their inefficiencies. Another factor contributing to inefficiencies of non-YM holders was the FB M&O expenses (the former spend 113% of the latter having achieved only the 87% of the FB revenue of the latter). Moreover, since the percentage of banqueting to total covers was similar for both groups and since non- YM holders controlled FB payroll as well as well as YM-holders (the former achieved the 87% of FB revenue of the latter by spending the 87% of YM users payroll), these two factors did not contribute to any differences in efficiency between the two groups. On the other hand, differences in Rooms division efficiency metrics revealed that non YM-holders had 80% room capacity of YM holders but achieved only the 76% of roomnights, the 96% of ARR and the 36.51% of non-room revenue of the latter. It is thus evident that the impact of YM on efficiency differences is mainly on enhancing occupancy, ARR and non-room revenue, but its impact is greater on managing capacity levels, boosting occupancy and non-room revenue rather than increasing ARR. Increased occupancy also explains why YM-holders could get more FB revenue than non-YM holders (since they had more hotel guests). Non-YM holders also spend relatively more Front Office payroll and Administration M&O expenses (the level of other expenses is justified by their size), but YM availability cannot explain such differences. In brief, YM effect on hotel overall operational efficiency is attributed to its capability to manage room capacity levels, boost ARR, FB and non-room revenue.

Table 9.4.1.3.e Configuration of Rooms and FB division efficiency determining inputs/outputs for YM holders and non holders

YM systems	**Yes (48)**	**No (45)**	**Ratio No/Yes**
FB revenue	1502790.7	1310026	0.871
Ratio banqueting to restaurant covers served	0.3530334	0.355421	1.006
FB capacity	283.8125	318.0889	1.120
FB M&O expenses	316257.63	360489.7	1.139
FB payroll	426934.46	371983.2	0.871
ARR	59.574222	57.5725	0.966
Roomnights	26249.438	20165.16	0.768
Non-room revenue	348891.69	127392.9	0.365
Number of rooms	100.33333	80.84444	0.805
Front Office payroll	114196.06	135553.8	1.187
Administration M&O expenses	117647.98	134919.4	1.146
Other room division payroll	354441.79	282878	0.798
Other room division M&O expenses	230884.69	183964.2	0.796

In order to investigate further the impact of YM systems on FB revenue a chi-square test was conducted in order to investigate whether YM systems holders and non holders significantly differ in their revenue orientation (Table 9.4.1.3.f). Indeed, the test revealed a significant relationship between revenue orientation and YM availability, indicating that YM holders significantly get more revenue from FB than Rooms Division, which in turn confirms the synergy effect that YM systems enable between Rooms and FB division.

Table 9.4.1.3.f Chi-Square investigating differences in revenue orientation between YM holders and non-holders

			YM system		Total
			No	Yes	
Revenue orientation	**Rooms division**	Count	20	12	32
		Expected Count	15.48387	16.516129	32
		% within O.2	44.44444	25	34.408602
		Std. Residual	1.147695	-1.111251	
	FB division	Count	25	36	61
		Expected Count	29.51613	31.483871	61
		% within O.2	55.55556	75	65.591398
		Std. Residual	-0.83126	0.8048636	
Total		Count	45	48	93
		Expected Count	45	48	93
		% within O.2	100	100	100

Continued...					
Chi-Square Tests					
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.890881	1	0.048549		
Continuity Correction	3.077022	1	0.079406		
Likelihood Ratio	3.919081	1	0.047741		
Fisher's Exact Test				0.0536926	0.0394441
Linear-by-Linear Association	3.849044	1	0.049774		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.48.

As concerns the impact of F&A systems on hotel productivity, it was previously found that the effect of F&A on Rooms division efficiency determining metrics was focused on controlling Front Office payroll expenses. Regarding, F&A effect on FB efficiency determining inputs/outputs, the configuration of the latter for F&A holders and non-holders is provided (Table 9.4.1.3.g). Efficiency differences between non F&A and F&A holders are mainly due to the underutilisation of the FB capacity of the former (they are of a similar size as the latter but achieve only the 68% of the latter's revenue), as well as in the lower ability of the latter to control their FB M&O expenses and payroll given their achieved level of FB revenue. It can thus be assumed that F&A holders can achieve higher hotel overall efficiencies because F&A systems allow them to gather and analyse data in order to control their expenses and exploit demand patterns (e.g. identify and target segments of hotel guests that are also the most profitable in terms of their FB spending).

Table 9.4.1.3.g Configuration of FB division efficiency determining inputs/outputs for F&A systems holders and non holders

F&A systems	**Yes (73)**	**No (20)**	**Ratio No/Yes**
FB revenue	1510825.9	1039742	0.688
Ratio banqueting to restaurant covers served	0.3340951	0.427529	1.279
FB capacity	300.08219	301.55	1.004
FB M&O expenses	358565.22	261357	0.728
FB payroll	422013.21	321256.6	0.761
Total business variability	3.4520548	3.25	0.941

As regards the impact of Management & Executive systems on hotel overall operational efficiency, it is evident that efficiency differences between holders and non holders are found in almost all efficiency determining factors in both Rooms and FB division (Table 9.4.1.3.h). So, system holders could achieve a higher FB revenue, ARR, non-room revenue and roomnights, better control their FB and Administration M&O expenses as well as FB and Front Office payroll. This is not surprising since these systems can significantly enhance the quality of decision making.

Table 9.4.1.3.h Configuration of Rooms and FB division efficiency determining inputs/outputs for M&E systems holders and non holders

Management and Executive systems	Yes (8)	No (85)	Ratio No/Yes
FB revenue	1514594.3	1399628	0.924
Ratio banqueting to restaurant covers served	0.4777646	0.342558	0.717
FB capacity	222.375	307.7412	1.383
FB M&O expenses	299076.38	341291.6	1.141
FB payroll	386137.63	401682.3	1.040
Total business variability	3.125	3.341176	1.069
ARR	63.385	58.08518	0.916
Roomnights	28665.125	22800.99	0.795
Non-room revenue	426897.55	224285.9	0.525
Number of rooms	98.875	89.62353	0.906
Front Office payroll	97967.5	127030.5	1.296
Administration M&O expenses	126525	125956.2	0.995
Other room division payroll	389616	313244.6	0.803
Other room division M&O expenses	205779.14	207851	1.010
Other hotel payroll	433039	369467.4	0.853
Other hotel M&O expenses	470750	429951.9	0.913

Table 9.4.1.3.i summarises the impact of conference & banqueting systems on hotel overall operational efficiency. Analytically, the following factors were found to affect efficiency differences between holders and non holders: a) the underutilisation of FB capacity of non holders (they had the same capacity with holders but achieved only the 76% of the FB revenue of the latter); b) a high overspending in FB payroll and a lower in FB M&O expenses (the percentage of banqueting to restaurant covers served cannot have affected these overspending, since this ratio was similar for both groups); c) underutilisation of rooms capacity of non holders (the latter had the 65% of rooms capacity of the holders but achieved only 59% of the roomnights of the latter); d) lower achieved ARR and non-room revenue by non holders; e) overspend in Front Office payroll and Administration M&O expenses (other expenses for non holders were at an expected level given their achieved level of roomnights).

It can thus be argued that conference & banqueting systems can help hotels control their FB expenses (both payroll and M&O), better manage their FB capacity and achieve higher revenue, as well as better co-ordinate FB and rooms division operations by boosting ARR and occupancy rates, i.e. rooms capacity utilisation rates. This latter effect on improving hotel overall operational efficiency is similar to the synergies effect between hotel divisions enabled by videoconferencing systems as well. Indeed, an analysis of the market segments served by holders and non holders of conference & banqueting systems revealed that banqueting and conference holders get more roomnights from business and conference guests and fewer roomnights from leisure guests than non systems holders (Table 9.4.1.3.j). However, as it was previously found configuration of roomnights per market segment did not affect efficiency and so, such differences cannot be claim to contribute to efficiency differences between system holders and non holders. However, the differences in roomnights configuration between system holder and non holders revealed the synergies effect that these system enable between hotel divisions, i.e. boost FB efficiency but also attract more conference and business travellers contributing to efficiency in rooms divisions as well.

Table 9.4.1.3.i Configuration of Rooms and FB division efficiency determining inputs/outputs for Conference & Banqueting systems holders and non holders

Conference & Banqueting systems	Yes (33)	No (57)	Ratio No/Yes
FB revenue	1666310.7	1268281	0.761
Ratio banqueting to restaurant covers served	0.3456699	0.358874	1.038
FB capacity	283.84848	309.5	1.090
FB M&O expenses	388938.85	309457	0.795
FB payroll	432434.48	382696	0.884
Total business variability	3.418182	3.183333	0.931
ARR	65.675455	54.61717	0.831
Roomnights	31555.667	18767.8	0.594
Non-room revenue	398747.28	155347.1	0.389
Number of rooms	116.0303	76.33333	0.657
Front Office payroll	105595.82	134944.5	1.277
Administration M&O expenses	100519.18	140022.4	1.392
Other room division payroll	416903.82	266414.9	0.639
Other room division M&O expenses	277523.47	168482.2	0.607
Other hotel payroll	517977.1	296263.3	0.571
Other hotel M&O expenses	624652.4	328306.4	0.525

Table 9.4.1.3.j ANOVA test investigating differences in configuration in roomnights per market segment between Conf & Banq Systems holders and non holders

% of roomnights from:	Banqueting systems & Conference Holders		Non Banqueting systems & Conference Holders	
	Mean	St. Dev	Mean	St. Dev
BUSINESS travellers	49.972727	19.79142	45.603333	22.168
LEISURE travellers	30.687879	19.21505	40.226667	25.514
CONFERENCE travellers	14.078788	8.33993	10.595	11.411

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
BUSINESS travellers	Equal variances assumed	1.307	0.256	0.944	91.000	0.348	4.369	4.630	-4.827	13.566
	Equal variances not assumed			0.976	72.640	0.333	4.369	4.479	-4.558	13.296
LEISURE travellers	Equal variances assumed	9.578	0.053	-1.874	91.000	0.044	-9.539	5.091	-19.652	0.575
	Equal variances not assumed			-2.032	82.219	0.043	-9.539	4.694	-18.877	-0.200
CONFERENCE travellers	Equal variances assumed	0.032	0.858	1.548	91.000	0.049	3.484	2.251	-0.988	7.955
	Equal variances not assumed			1.551	66.436	0.045	3.484	2.246	-1.001	7.968

The effect of F&B systems on hotel overall efficiency seems slightly to differ from the effect of conference & banqueting systems. Analytically, efficiency differences between F&B holders and non holders were attributed to the following factors (Table 9.4.1.3.k): a) underutilisation of FB capacity by non-F&B holders (11% capacity – 99% FB revenue=12%) but not as high as the underutilisation level of non conference & banqueting systems holders (109% capacity - 76% FB revenue=33%); b) overspending of non F&B holders in FB M&O but not in FB payroll, as it was in the case of conference & banqueting systems (this overspending is found although non holders have a higher banqueting to restaurant covers); c) as regards rooms division input/output metrics, non F&B holders are overspending in Front Office payroll and Administration M&O expenses.

However, as F&B non holders faced a lower business variability score (i.e. higher fluctuations in business) than holders, it could have been argued that the lower operational efficiency of non holders can be attributed to the non favourable business conditions within which they operated. However, this is not true because F&B systems had a significant effect on hotel overall market efficiency, meaning that when market conditions were taken into account holders still had a significantly higher hotel overall market efficiency score than non holders. In other words, F&B holders could also significantly better manage business fluctuations to achieve higher profits/profitability, i.e. get more revenue while at the same time controlling for their expenses, than non holders (Table 9.4.1.3.l). Consequently, F&B systems can both help in the efficient management of operations while at the same time control for the impact that market conditions could have on operations' efficiency.

Overall, when comparing the efficiency effect of F&B and conference and banqueting systems, it is evident that although the former were found only to control FB M&O expenses, the latter contributed both to the better management of FB capacity and FB expenses (both payroll and M&O expenses). F&B systems also contributed to both operational and market efficiency. In contrast to conference & banqueting ICT, the synergies effect between FB and Rooms division that F&B systems could have is not clear.

Table 9.4.1.3.k Configuration of Rooms and FB division efficiency determining inputs/outputs for F&B systems holders and non holders

F&B systems	Yes (41)	No (52)	Ratio No/Yes
FB revenue	1413695.9	1406223	0.994
Ratio banqueting to restaurant covers served	0.3164535	0.383941	1.213
FB capacity	281.09756	312.6154	1.112
FB M&O expenses	311824.29	360030.9	1.154
FB payroll	385255.34	412242.8	1.070
Total business variability	3.6341463	3.230769	0.889
ARR	56.709756	59.985	1.057
Roomnights	26166.78	21049.37	0.804
Non-room revenue	270846.13	218746	0.807
Number of rooms	96.463415	85.65385	0.887
Front Office payroll	101932.76	142347.9	1.396
Administration M&O expenses	78693.171	163308.8	2.075
Other room division payroll	354958.12	292104.5	0.822
Other room division M&O expenses	219031.41	199616.8	0.911
Other hotel payroll	410176	347150.4	0.846
Other hotel M&O expenses	484320	393361.4	0.812

Table 9.4.1.3.l Configuration of hotel overall market efficiency determining inputs/outputs for F&B systems holders and non holders

F&B systems	Yes (41)	No (52)	Ratio No/Yes
Total business variability	3.6341463	3.230769	0.889
Total revenue	2822108.7	2624830	0.930
Total profit	1008289	808388.1	0.801
Profit/Revenue (profitability ratio)	0.357282	0.307977	0.862

As concerns the productivity impact of stock and inventory systems, differences in hotel overall operational efficiency between holders and non holders are attributed to the following factors (Table 9.4.1.3.m): a) underutilisation of FB capacity by non holders; b) overspending in FB M&O and payroll by non holders; c) low levels of non-room revenue by non holders; d) overspending in Front Office and Administration M&O expenses by non holders. The business variability score was the same for both groups so it could not have affected differences in efficiency. It can thus be argued that the availability of stock and inventory systems could have affected the better management of FB expenses as well as Administration M&O expenses and in some way the low levels of FB capacity utilisation and non-room revenue. The latter can be based on the fact that hotels with stock and inventory systems availability can better control the availability levels of their supplies as well as achieve higher revenues by better matching supply with demand levels.

Table 9.4.1.3.m Configuration of Rooms and FB division efficiency determining inputs/outputs for stock & inventory systems holders and non holders

Stock & inventory systems	Yes (48)	No (45)	Ratio No/Yes
FB revenue	1460553.9	1355079	0.927
Ratio banqueting to restaurant covers served	0.3347111	0.349642	1.044
FB capacity	273.95833	328.6	1.199
FB M&O expenses	301882.85	375822.8	1.244
FB payroll	428478.46	370336.2	0.864
Total business variability	3.3958333	3.422222	1.007
ARR	58.886875	58.17222	0.987
Roomnights	29802.104	16375.64	0.549
Non-room revenue	373274.46	101384.7	0.271
Number of rooms	115.3125	63.86667	0.553
Front Office payroll	114717.9	134997.2	1.176
Administration M&O expenses	118909.15	133574.1	1.123
Other room division payroll	411185.9	222351	0.540
Other room division M&O expenses	288353.59	128815.1	0.446
Other hotel payroll	498586.3	243042.2	0.487
Other hotel M&O expenses	630534.4	223250.2	0.354

As concerns the productivity effect of EPOS systems, differences in the hotel overall efficiency between EPOS and non EPOS users were attributed to the following factors (Table 9.4.1.3.n): a) underutilisation of FB capacity by non holders; b) a small overspending in terms of FB payroll and M&O by non holders (this overspending cannot be attributed to the percentage of banqueting/restaurant covers served by each group since this ratio was found the same for both groups; c) lower ARR and non-room revenue achieved by non holders; d) overspending in Front Office payroll and Administration M&O expenses by non holders. Although holders had a lower business fluctuation score (meaning that they faced higher fluctuations of business) they had a higher efficiency score than non holders, it can be argued that EPOS availability has offset any inefficiencies that market conditions could have caused, e.g. by matching staff levels with demand patterns through more efficient management of the order process in peak periods by avoiding the use of more staff while also avoiding the loss of any potential order and so revenue. Thus, the efficiency effect of EPOS systems can be argued to be on revenue enhancement and control of FB expenses. The effect of EPOS on Administration M&O can only be justified in case EPOS are PMS integrated, which in turn allow the streamlining of other processes (e.g. procurement, Just In Time (JIT) applications, Stock & Inventory control, revenue control), but integration issues are investigated in the next section.

Table 9.4.1.3.n Configuration of Rooms and FB division efficiency determining inputs/outputs for EPOS holders and non holders

EPOS	Yes (59)	No (34)	Ratio No/Yes
FB revenue	1573487.6	1124981	0.714
Ratio banqueting to restaurant covers served	0.3663316	0.348312	0.950
FB capacity	306.59322	289.6471	0.944
FB M&O expenses	366161.37	288202.4	0.787
FB payroll	434134.9	341709.9	0.787
Total business variability	3.1764706	3.542373	1.115
ARR	61.235932	53.86471	0.879
Roomnights	26726.39	17369.06	0.649
Non-room revenue	317005.03	111064.3	0.350
Number of rooms	101.9661	70.38235	0.690
Front Office payroll	115371.36	140424.2	1.217
Administration M&O expenses	124941.1	127851.5	1.023
Other room division payroll	367682.2	236749	0.643
Other room division M&O expenses	239305.89	154033.5	0.643
Other hotel payroll	443869.8	255315.3	0.575
Other hotel M&O expenses	521649.7	280428.8	0.537

When examining the configuration of efficiency determining inputs/outputs for e-lock systems holders and non holders, it was revealed that differences in one input factor could have contributed to the productivity impact of such systems (Table 9.4.1.3.o). Specifically, relative to e-lock holders, non holders had higher levels of other hotel payroll despite their lower level of business.

Table 9.4.1.3.o Configuration of Rooms and FB division efficiency determining inputs/outputs for e-lock systems holders and non holders

e-lock systems	Yes (41)	No (52)	Ratio No/Yes
FB revenue	1431679.8	1392043	0.972
Ratio banqueting to restaurant covers served	0.314578	0.38542	1.225
FB capacity	257.90244	333.9038	1.294
FB M&O expenses	310829.63	358815.1	1.154
FB payroll	398081.34	402130	1.010
Total business variability	3.4146341	3.403846	0.99
ARR	62.555854	55.37558	0.885
Roomnights	33622.878	15170.52	0.451
Non-room revenue	411953.98	107487.9	0.260
Number of rooms	126.58537	61.90385	0.489
Front Office payroll	132171.66	118505.7	0.896
Administration M&O expenses	124947.1	126839.3	1.015
Other room division payroll	416668.44	243448.3	0.584
Other room division M&O expenses	311532.05	126689.7	0.406
Other hotel payroll	505955	271632.4	0.536
Other hotel M&O expenses	663047.6	252441.5	0.380

Concerning energy management systems, the statistical analysis (Table 9.4.1.3.p) indicated that the level of other M&O expenses for non systems holders was not justified by their lower levels of FB revenue and roomnights achieved. Energy expenses were included in other hotel M&O expenses and so, the impact of energy management systems might be apparent. Indeed, by calculating the energy costs for holders and non holders it is found that energy expenses of the latter did not match their configuration, i.e. non holders were of quite similar room and FB capacity as system holders (92% room capacity and 94% FB capacity) but because of their much lower achieved levels of business they would have been expected to pay less for energy expenses (56% of FB revenue, 84% of non-room revenue and 80% roomnights).

Table 9.4.1.3.p Configuration of Rooms and FB division efficiency determining inputs/outputs for energy management systems holders and non holders

Energy management systems	Yes (11)	No (82)	Ratio No/Yes
FB revenue	2301606.4	1289847	0.560
Ratio banqueting to restaurant covers served	0.4765516	0.337774	0.708
FB capacity	317	298.1707	0.940
FB M&O expenses	417444.18	326957.5	0.783
FB payroll	607631.64	372538.4	0.613
Total business variability	4.3636364	3.280488	0.751
ARR	67.406364	57.35183	0.850
Roomnights	28211	22647.37	0.802
Non-room revenue	279646.27	236626.5	0.846
Number of rooms	96.454545	89.60976	0.929
Front Office payroll	85658.818	129745	1.514
Administration M&O expenses	30455.727	138822.7	4.558
Other room division payroll	409901	307729.3	0.750
Other room division M&O expenses	206624	208822.7	1.010
Other hotel payroll	448323.1	365091.3	0.814
Other hotel M&O expenses	491980	425611.3	0.865
Energy expenses	117869.7	101347.9	0.859

Market efficiency

The availability of GDS was one of the two technologies that was found to affect market efficiency in the overall hotel property (the market efficiency effect of F&B systems is analysed above). In order to investigate the market efficiency impact of GDS a configuration analysis of the inputs/outputs affecting market efficiency for GDS holders and non-holders was conducted (Table 9.4.1.3.r). It was found that for the same revenue levels, hotels with GDS achieve higher profits meaning that GDS have actually contributed in the control of their expenses. The two groups operated within similar market conditions meaning that efficiency differences could not be attributed to market conditions. Thus, ultimately, the effect of GDS on market efficiency is due to its capacity to control hotel expenses.

Table 9.4.1.3.r Configuration of hotel overall market efficiency determinant inputs/outputs for GDS holders and non-holders

GDS	Yes (47)	No (46)	Ratio No/Yes
Total business variability	3.5106383	3.404348	0.9697233
Total revenue	2639235.8	2785947	1.0555884
Total profit	948928	842965.5	0.8883345
Profit/Revenue(Profitability)	0.359547	0.302578	0.841554

9.4.1.4 Summary of the impact of ICT availability on productivity metrics and on specific efficiency frontier determining inputs/outputs

Table 9.4.1.4.a summarises these results and complements Tables 9.4.1.a by indicating the productivity effect of the ICT (that were found to have a statistically significant effect on efficiency metrics) on specific inputs/outputs that in turn determine efficiency frontiers.

Table 9.4.1.4.a The productivity impact of ICT on productivity determining inputs/outputs

	PMS	Intranet	Guest database	YM	GDS	PBRS	FO system	F&A system	M&E system	Conf /Banq system	F&B system	Stock/Inv system	EPOS	Mini bars	Ondemand movies	Inroom Int&eml	e-lock system	Energy Manag.	Videoconferencing
ARR																			
Roomnights																			
Non-room revenue																			
Number of rooms																			
Front Office payroll																			
Administration M&O expenses																			
Other room division payroll																			
Other room division M&O expenses																			
FB revenue																			
Banqueting / restaurant covers served																			
FB capacity																			
FB M&O expenses																			
FB payroll																			
Total business variability																			
Other hotel payroll																			
Other hotel M&O expenses																			
Synergy effect between divisions																			

It is however evident from Table 9.4.1.a that not all investigated technologies were found to significantly affect any productivity metric. Indeed, the availability of only 19 out of the 33 investigated technologies positively impact on at least one type of efficiency. Since the availability of single technologies was not found to have a significant effect on efficiency, the following hypotheses were then tested:

1. Whether the availability of a cluster of technologies has a greater effect on efficiency than the availability of a single technology;
2. Coupled with the fact that the availability of a PMS was found to significantly affect efficiency, whether it is not only the availability but also the integration of a technology (or a cluster of technologies) with the PMS that significantly affects efficiency;
3. whether sophistication of use of ICT affects efficiency.

9.4.2 Impact of the number of ICT on productivity: productivity impact of cluster versus single ICT on efficiency

Since the examination of the impact of single ICT on productivity did not provide conclusive results regarding the ICT productivity impact, this section will test whether the availability of a cluster of ICT provides a more clear effect on productivity. This is worthwhile examining, since ICT clusters might entail several synergies and complementarities amongst technologies, which can in turn significantly impact on productivity. In particular, the productivity impact of the following clusters of technologies was tested (Table 9.4.2.a): the number of distribution technologies, the number of reservation technologies, the number of in-room technologies, the number of ICT in rooms division, in FB and in the hotel property, the number of general ICT, number of critical success technologies.

Table 9.4.2.a Cluster of technologies

Number of distribution technologies (1)	Website online reserv., reservations through e-mail, GDS, Property based, CRS
Number of reservation technologies (2)	Technologies in (1), YM, Customer Database, M&S
Number of in-room technologies (3)	Office facil., TV based services, Voice mail, On demand movies, In-room internet access, Automated mini-bars
Number of ICT in Rooms division only (4)	Front Office system, Telephone system, PBRS, CRS, YM, GDS, M&S, Check in/out kiosks, smart cards
Number of ICT in FB division only (5)	Conf. & Banq. systems, FB systems, Stock & Invent. Systems, EPOS
Number of non FB division ICT (6)	(7) – (5)= (4) + (9)
Number of ICT in whole hotel property (7)	27 technologies
Critical success technologies (8)	PMS, Website, Email, Intranet, Extranet, Customer Database
Number of general ICT (9)	F&A, e-lock, HRM, energy mangmt, MSS, e-procurement, Videoconferencing, DSS
Overall number of ICT	(7) + (8)

For testing the effect of ICT clusters on efficiency metrics the following tests were conducted:

- Two-tailed Pearson correlations between the number of ICT within each cluster and the raw efficiency scores for the following efficiency metrics: Rooms 3, Rooms 4, FB4, Tot.oper and mark.eff (tests' results are given in Appendix F.2.1)
- since the raw market efficiency score was not available, T-tests compared the mean number of ICT within each cluster between market efficient and market inefficient hotels in rooms division, (tests' results are given in Appendix F.2.2)

A summary of these tests is provided in Table 9.4.2.b whereby clusters of ICT that were found to significantly impact on a productivity metric are indicated with an asterisk.

Table 9.4.2.b Productivity impact of the availability of single versus clusters of ICT

	Rooms division			FB	Overall	
	Oper. Rooms3 (t-test)	Market Cl. 3+4 (Cros.tab)	Comb. Rooms 4 (t-test)	Comb. FB4 (t-test)	Oper. Tot.oper (t-test)	Market Mark.eff (t-test)
PMS	*				*	
Website	n.a.		n.a.	n.a.	n.a.	n.a.
Email	n.a.		n.a.	n.a.	n.a.	n.a.
Intranet		*				
Extranet						
Customer Database/Warehouse	*					
Critical success technologies						
YM					*	
GDS						*
Central Reservation System						
Property based Reservation System	*					
Marketing and Sales Systems						
Number of distribution ICT	*					*
Number of reservation ICT	*				*	*
Front Office System	*					
Smart Cards	n.a.		n.a.	n.a.	n.a.	n.a.
Telephone System						
Check in/out kiosks						
HRM system						
F&A system	*				*	
Decision Support Systems	n.a.		n.a.	n.a.	n.a.	n.a.
Management or Executive Systems					*	
Number of general ICT	*			*	*	
Number of ICT in Rooms Division only	*					
Number of non FB ICT, i.e. general ICT plus Rooms division ICT	*	*		*		
Conf & Banq Systems	*				*	
F&B Systems					*	*
Stock & Inventory Systems	*		*		*	
EPOS	*		*		*	
Number of ICT in FB division only	*				*	
Automated mini bars				*		
In room offices facilities						
TV based services						
Voice mail						
On demand movies/games			*			
In room Internet/e-mail access			*			
Number of In-room technologies						
e-procurement system						
Electronic lock system					*	
Energy Management System					*	
Videoconferencing Systems				*	*	
Number of ICT in whole hotel	*	*			*	
Overall number of ICT	*	*			*	

An ICT effect cannot be theoretically based

n.a. only a small number of units (less than 5) had (not) the technology

9.4.2.1 Productivity impact of critical success ICT

As no significant correlation coefficients between the total number of critical success ICT and the efficient metrics were found, it was concluded that the number of critical success factors cannot significantly result in productivity gains.

9.4.2.2 Productivity impact of distribution ICT

The availability of any single distribution ICT did not affect efficiency, apart from the availability of the Property Based Reservation System that affected operational efficiency in Rooms division and the availability of GDS that affected overall market efficiency. This does not however mean that investment on distribution ICT is not worthwhile. As Table 9.4.2.b indicates, it was found that hotels with a greater number of distribution ICT were more efficient in room's operational efficiency and overall market efficiency than hotels with fewer distribution ICT. That means that the number of distribution ICT enabled hotels to manage their rooms operations more efficiently by achieving a good configuration of operational efficiency determining input/outputs, i.e. achieve greater ARR, roomnights, non-room revenue while controlling for their front office payroll, administration non-payroll expenses and other hotel expenses (payroll and non-payroll). Moreover, the availability of a greater number of distribution ICT enabled hotels to better manage business variability for achieving higher overall market efficiency than hotels with fewer distribution ICT. Thus, the synergy of distribution technologies, i.e. the complementarities between them, that enables hotels to make their properties available at any time, any place and to different electronic platforms and that gives guests the option to access multiple points of touch for reservations, enquiries etc. depending on their circumstances, is confirmed. Gaining the greatest exposure in the digital market place is vital for managing business variability and achieving overall market efficiency as well as room division operational efficiency.

9.4.2.3 Productivity impact of reservations ICT

As with distribution ICT, significant correlation coefficients between reservations ICT and efficiency metrics indicated that the former can significantly contribute to greater operational efficiency in rooms division and total market efficiency. However, the greater number of reservations ICT was found to significantly affect total operational efficiency indicating the synergy effect that the reservations but not distribution ICT could have between rooms and FB division.

9.4.2.4 Productivity impact of general ICT

Significant Pearson correlation coefficients between the number of general ICT and efficiency metrics revealed that the former can significantly positively affect operational efficiency in Rooms and FB division, as well as in the whole hotel property as a whole. The last fact indicates that general ICT also enable the synergetic effect between Rooms and FB division for boosting overall efficiency.

9.4.2.5 Productivity impact of Rooms division ICT

Significant correlation coefficients indicated that the greater number of rooms division ICT can result in greater operations efficiency in rooms division. No significant effect on overall efficiency was found, meaning that ICT in Rooms division do not result in synergy effect between hotel divisions.

9.4.2.6 Productivity impact of non FB ICT

Statistical tests revealed that the greater the number of non FB ICT the greater the operational efficiency in rooms division and overall property as well as the greater the market efficiency in rooms division. However, as the number of non FB ICT is the sum of general and rooms division ICT, it is clear that non FB ICT did not have a synergy effect since the general ICT significantly affected FB and overall efficiency but rooms division ICT did not. On the other hand, since general and rooms division ICT did not significantly affect market efficiency, the significant effect of their total ICT number on market efficiency should be attributed to the synergetic effect of both of them.

9.4.2.7 Productivity impact of in-room ICT

No significant correlation coefficients between the number of in-room ICT and efficiency metrics were found indicating that the former cannot significantly result in efficiency gains.

9.4.2.8 Productivity impact of FB ICT

It is interesting to note that neither single FB technologies nor their cluster had a significant effect on efficiency. However, the cluster of FB ICT was found to significantly contribute to total operational efficiency highlighting the synergy effect that FB ICT foster between rooms and FB division.

9.4.2.9 Productivity impact of total ICT

The total number of ICT in the hotel property was significantly positively correlated with operational and market efficiency in rooms division as well as with total operational efficiency.

9.4.2.10 Productivity impact of total and critical success ICT

The total number of ICT in the hotel property and the critical success ICT was significantly positively correlated with operational and market efficiency in rooms division as well as with total operational efficiency.

Overall, it is interesting to note that although the availability of single ICT was not found to affect market efficiency (apart from certain exceptions) the availability of certain clusters of ICT significantly contributed to higher market efficiency scores. Moreover, although FB technologies were found to significantly affect total efficiency indicating a synergy effect between divisions, clusters of rooms ICT were not found to significantly affect FB efficiency and so to foster an efficiency synergetic effect between hotel divisions.

Two-tailed t-tests were conducted in order to investigate whether the revenue orientation of hotels affected the number of ICT adopted within each cluster (Table 9.4.2.c). The investigation of the impact of revenue orientation on the number of ICT was important because as previous analysis indicated revenue orientation significantly affected productivity in rooms and FB division (i.e. hotels that got more revenue from FB were significantly more FB efficient than hotels that got more revenue from rooms division, while the latter had a significantly higher efficiency score than the former in rooms division). Thus if revenue orientation significantly affected the number of ICT in each cluster then it could be argued that the synergy and productivity effect of clusters of ICT is due to the revenue orientation of the hotel and not the synergy of ICT within the cluster. However, as it was revealed that revenue orientation did not significantly affect the availability of the number of any cluster of ICT, it was concluded that the synergetic productivity effect of ICT clusters cannot be attributed to the revenue orientation of respondents.

Table 9.4.2.c TT-Tests investigating differences in the number of ICT within clusters for Rooms and FB division revenue orientated hotels

	revenue orientation	N	Mean	Std. Deviation	Std. Error Mean
GDS, PBRS, CRS, web.online, eml.res	rooms	32	3.03125	1.062085	0.187752
	fb	61	2.983607	1.297328	0.166106
o.distr and YM, database, market/sales	rooms	32	4.5	1.900764	0.336011
	fb	61	4.737705	2.151756	0.275504
O.INROOM	rooms	32	1.625	1.385408	0.244908
	fb	61	2.098361	1.556759	0.199323
O.ROM	rooms	32	4.71875	1.938313	0.342649
	fb	61	4.819672	2.202334	0.28198
O.FB	rooms	32	1.84375	1.297874	0.229434
	fb	61	2	1.316561	0.168568
total number of tec minus fb	rooms	32	12.03125	4.540033	0.802572
	fb	61	12.36066	5.205871	0.666543
O.TOTAL	rooms	32	10.71875	4.814189	0.851036
	fb	61	11.54098	5.439282	0.696429
pms, web, eml, intra, extra, database	rooms	32	3.90625	0.892961	0.157855
	fb	61	3.882904	1.103337	0.141268
O.GENERA	rooms	32	1.8125	1.255632	0.221967
	fb	61	1.721311	1.495896	0.19153
total tec and pms, web, eml, intra, extra	rooms	32	13.875	5.277768	0.932986
	fb	61	14.5082	6.144436	0.786714

	Levene's Test for Equality of Variances			t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1	Equal variances assumed	0.693	0.407	0.179	91.000	0.859	0.048	0.267	-0.482	0.578
	Equal variances not assumed			0.190	74.833	0.850	0.048	0.251	-0.452	0.547
2	Equal variances assumed	0.066	0.798	-0.526	91.000	0.600	-0.238	0.452	-1.135	0.660
	Equal variances not assumed			-0.547	70.281	0.586	-0.238	0.435	-1.104	0.629
3	Equal variances assumed	0.077	0.783	-1.445	91.000	0.152	-0.473	0.328	-1.124	0.177
	Equal variances not assumed			-1.499	69.838	0.138	-0.473	0.316	-1.103	0.156
4	Equal variances assumed	0.106	0.746	-0.218	91.000	0.828	-0.101	0.462	-1.018	0.817
	Equal variances not assumed			-0.227	70.500	0.821	-0.101	0.444	-0.986	0.784
5	Equal variances assumed	0.018	0.894	-0.546	91.000	0.586	-0.156	0.286	-0.724	0.412
	Equal variances not assumed			-0.549	63.883	0.585	-0.156	0.285	-0.725	0.413
6	Equal variances assumed	0.037	0.849	-0.302	91.000	0.763	-0.329	1.089	-2.493	1.834
	Equal variances not assumed			-0.316	71.048	0.753	-0.329	1.043	-2.410	1.751
7	Equal variances assumed	0.043	0.836	-0.720	91.000	0.474	-0.822	1.143	-3.092	1.447
	Equal variances not assumed			-0.748	70.164	0.457	-0.822	1.100	-3.015	1.371
8	Equal variances assumed	0.722	0.398	0.103	91.000	0.918	0.023	0.226	-0.426	0.473
	Equal variances not assumed			0.110	75.514	0.913	0.023	0.212	-0.399	0.445
9	Equal variances assumed	0.236	0.628	0.294	91.000	0.769	0.091	0.310	-0.524	0.706

	Equal variances not assumed			0.311	73.341	0.757	0.091	0.293	-0.493	0.675
7 + 8	Equal variances assumed	0.119	0.731	-0.495	91.000	0.622	-0.633	1.280	-3.176	1.909
	Equal variances not assumed			-0.519	71.960	0.605	-0.633	1.220	-3.066	1.800

Two-tailed t-tests were also conducted in order to investigate whether market orientation of respondents affected the number of ICT adopted in each ICT cluster (Table 9.4.2.d). Previous analysis revealed that market orientation did not significantly affected productivity and so the any relationship between market orientation and the number of ICT within each cluster cannot be concluded to have confounded the synergy productivity effect of the clusters of ICT. However, this analysis was conducted in order to examine if certain types of ICT can benefit certain types of hotels. It was found that market orientation significantly affected the number of ICT that respondents had within all ICT clusters apart from cluster referring to critical success ICT. Specifically, hotels getting more roomnights from business customers were found to have a significant greater number of distribution, reservation, in-room, rooms division, general, non FB division, FB and total ICT than hotels that got more roomnights from leisure guests. It was so concluded that the number of critical success ICT is vital for all hotels irrespective of their market orientation.

Table 9.4.2.d T-tests investigating differences in the number of ICT within clusters for business and leisure market oriented hotels

	ORIENTAT	N	Mean	Std. Deviation	Std. Error Mean
GDS, PBRS, CRS, web.online, eml.res	business	64	3.203125	1.100933	0.137617
	leisure	29	2.551724	1.351882	0.251038
o.distr and YM, database, market/sales	business	64	4.984375	1.855855	0.231982
	leisure	29	3.931034	2.328872	0.432461
O.INROOM	business	64	2.171875	1.548729	0.193591
	leisure	29	1.413793	1.296072	0.240675
O.ROM	business	64	5.296875	1.796643	0.22458
	leisure	29	3.655172	2.118803	0.430591
O.FB	business	64	2.171875	1.316015	0.164502
	leisure	29	1.448276	1.152209	0.21396
total number of tec minus fb	business	64	13.48438	4.353405	0.544176
	leisure	29	9.517241	5.20728	0.966968
O.TOTAL	business	64	12.54688	4.696942	0.587118
	leisure	29	8.413793	5.267944	0.978233
pms, web, eml, intra, extra, database	business	64	4.03125	0.942283	0.117785
	leisure	29	3.581281	1.161789	0.215739
O.GENERA	business	64	2.03125	1.402591	0.175324
	leisure	29	1.137931	1.245682	0.231317
total tec and pms, web, eml, intra, extra	business	64	15.78125	5.091134	0.636392
	leisure	29	11	6.117889	1.136064

										Continued….
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1	Equal variances assumed	2.539	0.115	2.458	91.000	0.016	0.651	0.265	0.125	1.178
	Equal variances not assumed			2.275	45.530	0.028	0.651	0.286	0.075	1.228
2	Equal variances assumed	4.246	0.052	2.337	91.000	0.022	1.053	0.451	0.158	1.949
	Equal variances not assumed			2.146	44.784	0.037	1.053	0.491	0.065	2.042
3	Equal variances assumed	1.528	0.220	2.295	91.000	0.024	0.758	0.330	0.102	1.414
	Equal variances not assumed			2.454	64.039	0.017	0.758	0.309	0.141	1.375
4	Equal variances assumed	4.925	0.051	3.719	91.000	0.000	1.642	0.441	0.765	2.519
	Equal variances not assumed			3.381	43.863	0.002	1.642	0.486	0.663	2.621
5	Equal variances assumed	1.605	0.208	2.550	91.000	0.012	0.724	0.284	0.160	1.287
	Equal variances not assumed			2.681	61.358	0.009	0.724	0.270	0.184	1.263
6	Equal variances assumed	0.579	0.449	3.825	91.000	0.000	3.967	1.037	1.907	6.027
	Equal variances not assumed			3.575	46.472	0.001	3.967	1.110	1.734	6.200
7	Equal variances assumed	0.130	0.720	3.784	91.000	0.000	4.133	1.092	1.963	6.303
	Equal variances not assumed			3.623	48.981	0.001	4.133	1.141	1.840	6.426
8	Equal variances assumed	1.996	0.161	1.981	91.000	0.051	0.450	0.227	-0.001	0.901
	Equal variances not assumed			1.831	45.388	0.074	0.450	0.246	-0.045	0.945
9	Equal variances assumed	1.173	0.282	2.942	91.000	0.004	0.893	0.304	0.290	1.496
	Equal variances not assumed			3.078	60.532	0.003	0.893	0.290	0.313	1.474
7 + 8	Equal variances assumed	0.659	0.419	3.935	91.000	0.000	4.781	1.215	2.368	7.195
	Equal variances not assumed			3.672	46.303	0.001	4.781	1.302	2.161	7.402

9.4.3 Productivity impact of the integration of ICT

9.4.3.1 Productivity impact of the integration of ICT with the PMS

Considering that the availability of a PMS was found to significantly affect efficiency, the hypothesis whether it is not only the availability but also the integration of a technology (or a cluster of technologies) with the PMS that significantly affects efficiency was tested. To that end the following tests were conducted:

For investigating the productivity effect of PMS integration of single technologies

- ANOVA tests in order to test whether hotels without the ICT, with the ICT but not PMS integrated and with the ICT but PMS integrated significantly differ in their ROOM 3, Room 4, FB4, Tot.oper and mark.eff score. The Kruskal-Wallis H non parametric tests was also undertaken in cases where the assumptions of equality of variances was violated. These tests are provided in Appendix F.3.1.
- Chi-Square tests in order to examine whether no availability, availability but no PMS integration, availability and PMS integration had an effect on market efficiency in rooms division. Chi-Square tests had to be conducted since the raw market efficient scores could not be calculated but instead hotels were only identified as efficient and inefficient. These tests are provided in Appendix F.3.2.

For investigating the productivity effect of PMS integration of clusters of ICT

- Pearson two-tailed correlations between the percentage of PMS integrated ICT within clusters and Rooms 3, Rooms, 4, FB 4, Tot.oper, and mark.eff. These tests are provided in Appendix F.3.3.
- T-tests investigating whether market efficient hotels in rooms division had a significantly greater percentage of PMS integrated ICT within a cluster than market inefficient hotels. These tests are provided in Appendix F.3.4.

A summary of these tests is provided in Table 9.4.3.1.a; technologies whose integration with PMS had a statistically significant effect on efficiency are indicated with an "I", meaning that hotels having the technology integrated with the PMS had a significantly higher efficiency score from those that only had the technology but not integrated and/or from those that did not even have the technology. The direction of the productivity impact of the PMS integration is given in the parenthesis.

Table 9.4.3.1.a Comparison between the productivity effect of availability and integration efficiency effect of single and cluster of ICT

	Synerg.	Rooms division			FB	Overall	
		Oper. Rooms3 (t-test)	**Market** Cl. 3+4 (Cros.tab)	**Comb.** Rooms 4 (t-test)	**Comb.** FB4 (t-test)	**Oper.** Tot.oper (t-test)	**Market** Mark.eff (t-test)
Customer Database/Warehouse		*					
				I(2,0)	I (2,1)		
YM	*					*	
					I(2,0) (2,1)	I(2,0)	
GDS							*
Central Reservation System							
Property based Reservation System		*					
		I (2,0)					
Marketing and Sales Systems							
Number of distribution technologies		*					*
[redacted]							
Number of reservation technologies	*	*				*	*
[redacted]					I		
Smart Cards		n.a.		n.a.	n.a.	n.a.	n.a.
Telephone System							
		I (2,0)				I (2,0)	
Check in/out kiosks							
HRM system							
I integrated with efficiency score		100	100	100	100	100	75
F&A system	*	*				*	
					I (2,0)		

Continued…

Decision Support Systems		n.a.		n.a.	n.a.	n.a.	n.a.
Management or Executive Systems	*					*	
2 units integrated efficiency score						100	
Number of general ICT	*	*			*	*	
[redacted]					I		
Number of ICT in Rooms Division only		*					
[redacted]							
Number of non FB ICT	*	*	*		*		
[redacted]					I		
Conf & Banq Systems	*	*				*	
		I (2,0)					
F&B Systems						*	*
					I (2,0) (2,1)		
Stock & Inventory Systems	*	*		*		*	
		I (2,0)			I (2,1)		
EPOS	*	*		*		*	
		I (2,0)			I (2,1)		
Number of technologies in FB Div. only	*	*				*	
[redacted]					I		
Automated mini bars					*		
					I (2,1)		
In room offices facilities							
TV based services							
Voice mail 3 units had it integrated		96.12		100	87.8	100	62.7
On demand movies/games				*			
In room Internet/e-mail access				*			
Number of In-room technologies							
[redacted]							
e-procurement system							
Electronic lock system						*	
						I (2,0)	
Energy Management System						*	
3 units integrated efficiency score						100	
Videoconferencing Systems	*				*	*	
None unit had it integrated							
Number of ICT in hotel property	*	*				*	
[redacted]					I		

0= not ICT availability
1=ICT availability only
2=ICT availability and integration with PMS

In general, availability of specific technologies was not found significantly to affect market efficiency, either in rooms division or in overall property. Indeed, (apart from certain exceptions) neither the availability of single and/or clusters of ICT nor their integration with PMS could significantly help hotels to manage or exploit business fluctuations.

As concerns the integration productivity effect of specific clusters of ICT, availability of FB ICT did not have any significant effect on FB efficiency, but their integration with the PMS did. This fact highlights the importance of systems integration for efficiency benefits within the FB division as well as indicates that the potential synergy effect that FB ICT can have between hotel divisions can in some extent foster and enhance the productivity impact that their PMS integration can also have. The importance of the productivity effect of PMS integration is confirmed in the cases of other ICT clusters as well, whereby a synergy effect is being found together with an integration effect. Indeed, the synergetic effect of general ICT and total ICT is followed by an integration productivity effect, while in the case of in-room ICT and non FB neither a synergy nor an integration productivity effect is found; on the other hand, the integration effect of non FB ICT (i.e. general plus rooms division ICT) is mainly attributed to the integration effect of general ICT since rooms division ICT did not have any.

The importance of the integration productivity effect is also clear when considering single ICT found in each hotel division as well as in the whole hotel property. In rooms division, for ICT whose availability had a significant productivity impact an integration effect was also found. So, a customer database can help hotels manage their rooms division operations as well as efficiently control the market conditions when it is PMS integrated. The availability of a PBRS has a productivity effect on operational efficiency because respondents with PMS integrated systems (and not simple availability) had a significantly higher efficiency score. Only telephone systems were found to have an integration effect on operational efficiency without having an availability effect. However, as respondents that had an integrated telephone system (and not simple availability) significantly differ from those that did not claim availability (i.e. the direction of the integration effect), it highlights that is the integration rather than simple availability of a telephone system that matters.

In the FB division, the availability of no FB ICT had a significant effect on FB efficiency, as those that had integrated three FB ICT namely F&B, stock & Inventory systems and EPOS had a significantly higher FB efficiency score from those that only had them, meaning that simple availability is not enough for efficiency gains but PMS integration is extremely important. Specifically, the availability of FB ICT namely, Conference & Banqueting, Stock & Inventory Systems and EPOS have a significant effect on rooms operational efficiency because those with integrated systems (and not simple availability) had a significantly higher efficiency score from respondents with no availability. Thus, the synergetic effect of FB ICT between rooms and FB division is enabled because of their PMS integration. On the other hand, for Stock & Inventory systems and EPOS, significant differences between integration and no availability were not found meaning that there are some respondents without ICT availability that can do as well as those with integrated Stock & Inventory and EPOS systems.

In the hotel property as a whole, the availability of rooms division ICT have a significant effect on overall efficiency when they also have an integration efficiency effect in the FB division, and vice versa FB ICT have an efficiency effect on overall efficiency when they have an integration effect on the efficiency of rooms division. The same issue is found for general ICT. The availability of e-lock, energy management, F&A, M&E systems had a significant effect on overall efficiency because an integration effect was present. Thus, in order to enable a synergetic productivity impact between hotel divisions, ICT in specific divisions should be integrated with the hotel PMS.

Overall, it is made clear that the measurement of ICT reflecting only systems availability and its correlation with productivity scores may obscure the ICT productivity impact and lead to unreliable and inconsistent results because a crucial ICT factor that is really responsible for enhancing productivity (i.e. ICT use and integration) is being neglected.

9.4.3.2 Productivity impact of direct integrations among ICT

Because respondents reported to directly integrate ICT in order to overcome systems compatibility problems or lack of PMS, it is worthwhile examining whether overall direct systems integration apart from PMS has any effect on efficiency. To that end, a reliable metric reflecting the degree of integration of ICT (i.e. the spread of an ICT integration across other ICT) needed to be calculated and then correlated with productivity scores. To achieve that, the following procedure was followed. For each available ICT of every respondent, a total integration score was calculated by summing up the number of ICT (including the PMS) that are integrated with the former. This score was then divided by the number of ICT that could have been linked, i.e. the number of available ICT within its cluster minus 1 (itself), in order to get the percentage of available ICT integrated with the PMS. Percentages rather than raw numbers of integration scores were used to investigate the systems integration productivity impact in order to separate the productivity effect of ICT availability from that of their integration. That is because those with fewer ICT inherently have a lower integration score and vice versa, i.e. the raw integration scores also reflect ICT availability. Integration percentages were correlated with efficiency metrics (results are provided in Appendix F.3.5), while since raw efficiency scores were not available for rooms division market efficiency, t-tests were conducted in order to examine whether market efficient hotels had a significantly higher percentage of systems integration than market inefficient hotels (Appendix F.3.6). Actually, these tests were conducted separately for PMS holders and non holders (since these two groups had different patterns of systems integration, section 9.1.4.1) and for ICT where direct integrations were reported.

Results revealed that systems integration either for PMS holders or non PMS holders did not significantly contribute to rooms market efficiency. Moreover, for PMS holders, systems integration with FO system did not also have any integration operations efficiency effect, indicating that FO systems cannot actually substitute PMS, while integration of reservations and distribution ICT with YM and databases did have a significant effect on overall operational efficiency and FB efficiency respectively. Specifically, respondents that had a greater number of their reservation and distribution ICT integrated with YM had a significantly higher operational efficiency score (confirming Sigala et al, 2001c), while respondents that had a great percentage of their reservation and distribution ICT integrated with their customer database achieved a significant FB efficiency. These findings confirmed again the importance of systems integration for enabling the ICT synergy effect between hotel divisions.

9.4.4 Productivity impact of sophistication of use of critical success ICT

In order to investigate the productivity effect of the level of sophistication of use of critical success ICT the following tests were conducted:

- Two-tailed Pearson correlations between the sophistication score for each ICT and Rooms 3, Rooms 4, tot.oper., mark.eff, since raw efficiency scores were available (results in Appendix F.4.1);
- Two tailed t-tests in order to examine whether market efficient hotels had a significantly higher sophistication score from market inefficient hotels in rooms division, since the raw efficient scores were not available (results in Appendix F.4.2);
- For ICT whose sophistication of use had a significant productivity impact, further tests were conducted for investigating the specific features of ICT use that led to efficiency differences. Specifically three efficiency groups of respondents (i.e. efficient units, units with an inefficient score above as well as below the median inefficiency score) were compared on their features of ICT sophistication use by using chi-square tests (Appendix F.4.3). Features of ICT use that indicated significant differences between the three efficiency groups were argued to have contributed to efficiency differences.

A summary of the tests' results is provided in Table 9.4.4.a.

Table 9.4.4.a Productivity effect of critical success ICT's sophistication of use

	Rooms division			**FB**	**Overall**	
	Oper. Rooms3 (t-test)	Market Cl. 3+4 (Cros.tab)	**Comb.** Rooms 4 (t-test)	**Comb.** FB4 (t-test)	**Oper.** Tot.oper (t-test)	Market Mark.eff (t-test)
PMS	*				*	
			S			
Website	n.a.		n.a.	n.a.	n.a.	n.a.
Email	n.a.		n.a.	n.a.	n.a.	n.a.
Intranet		*				
	S					
Extranet						
Customer Database/Warehouse	*					
	S	S	S	S	S	S
Critical success technologies						

Overall, the total sophistication score of the six critical success ICT did not significantly affect efficiency metrics. However, the sophistication of use of three critical success ICT was found to affect efficiency. Specifically, sophistication of use of PMS significantly contributed in the efficient management of rooms operations while also considering market conditions, respondents with high sophistication score in their Intranet systems had a significantly higher rooms division operational efficiency score, while respondents making a more sophisticated use of their database scored significantly higher in all efficiency metrics.

As concerns the specific features of use that lead to productivity differences, cross-tabulations between efficiency groups and features of sophistication of use revealed the following. Data in Table 9.4.4.b provide a summary of the cross-tabulations between the three efficiency groups and their PMS sophistication use. It is clear that simple availability of PMS cannot result in efficiency gains (the three efficiency groups accounted for similar levels of PMS adoption, i.e. 81.81%, 87.09% and 82.76% respectively). Moreover, almost all respondents within each group used the PMS for automation purposes, indicating that all respondents have already passed the first stage of PMS implementation, i.e. automate their processes. On the contrary, efficient units were found significantly to differ in their PMS use in terms of informate and transformate applications, i.e. communication, collection, sharing and analysis of information for enhanced decision making as well as the use of PMS as an systems integration platform for enabling such sophistication applications. Indeed, an ANOVA test revealed that the three groups had a significantly different proportion of their total number of ICT integrated with their PMS (Tables 9.4.4.c). Overall, it was confirmed that enhanced features of PMS use can lead to increased productivity gains.

Table 9.4.4.b Comparison of PMS sophistication of use between the three efficiency groups

Combined efficiency in Rooms division (No. of units in efficiency group with PMS / No. of units in efficiency group)	*Efficient* (27/33=81.81%)		Above median (27/31=87.09%)		Below median (24/29=82.76%)	
PMS use	N	%	N	%	N	%
Automate front office operations (1)	26	96.30	26	96.30	23	95.83
Automate back office operations (1)	26	96.30	21	77.78	22	91.67
Communicate and share information between departments (3)	17	62.96	7	25.93	11	45.83
Collect and store data (3)	24	88.89	19	70.37	13	54.17
Analyse data and/or produce reports (5)	23	85.19	16	59.26	12	50.00
Create a platform that supports other applications (5)	21	77.78	9	33.33	9	37.50

Table 9.4.4.c ANOVA test investigating the differences in percentage of total ICT integrated with the PMS amongst the three efficiency groups

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
PMS						Lower Bound	Upper Bound		
yes	0	27	0.710773	0.157317	0.030276	0.64854	0.773005	0.5	1
	1	27	0.485343	0.248217	0.047769	0.387151	0.583534	0	0.882353
	2	24	0.417379	0.252042	0.051448	0.310951	0.523807	0	0.888889
	Total	78	0.542464	0.253159	0.028665	0.485386	0.599543	0	1

Test of Homogeneity of Variances				
percentage of integration of all tec with PMS				
PMS	Levene Statistic	df1	df2	Sig.
Yes	3.359605	2	75	0.050054

Continued...

ANOVA

percentage of integration of all tec with PMS

PMS		Sum of Squares	df	Mean Square	F	Sig.
Yes	Between Groups	1.228459	2	0.614229	12.42896	2.18E-05
	Within Groups	3.706441	75	0.049419		
	Total	4.9349	77			

Multiple Comparisons-Scheffe

PMS	(I) RANK4	(J) RANK4	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Yes	0	1	0.22543	0.060504	0.001715	0.074325	0.376535
		2	0.293394	0.062366	6.15E-05	0.137638	0.449149
	1	0	-0.22543	0.060504	0.001715	-0.37654	-0.07433
		2	0.067964	0.062366	0.554805	-0.08779	0.223719
	2	0	-0.29339	0.062366	6.15E-05	-0.44915	-0.13764
		1	-0.06796	0.062366	0.554805	-0.22372	0.087792

* The mean difference is significant at the .05 level.

As concerns the impact of specific features of Intranet use, because of the very small number of respondents that reported availability of an Intranet as well as the very small number of those that reported use of any feature, cross tabulations could not have been conducted. However, from raw data (Table 9.4.4.d) it can be argued that two features could have led to efficiency differences namely the use of Intranet for reservations and bookings and for external communication. Thus, a first stage of Intranet implementation, i.e. automation phase and storage of information, cannot contribute to enhanced efficiency gains.

Table 9.4.4.d Comparison of Intranet sophistication of use between the three efficiency groups

Operational efficiency in Rooms division (No. of units in efficiency group with Intranet / No. of units in efficiency group)	Efficient (8/16=50%)		Above median (14/39=35.89%)		Below median (8/38=21.01%)	
Intranet use	N	%	N	%	N	%
Automate front office operations (1)	3	37.50	2	14.29	1	12.50
Automate back office operations (1)	3	37.50	2	14.29	1	12.50
Store information (1)	8	100.00	6	42.86	7	87.50
Room reservations & bookings (3)	6	75.00	4	28.57	1	12.50
Conduct transactions with suppliers (3)	3	37.50	2	14.29	1	12.50
Enable internal communication & co-operation (5)	7	87.50	11	78.57	5	62.50
Enable external communication (5)	5	62.50	3	21.43	0	0.00

The same conclusions are derived when the effect of specific features of customer database use is examined. For example, Table 9.4.4.e summarises the results of chi-square tests (Appendix F.4.3) when the operational efficiency in rooms division is considered. Results revealed that it was not the automation features of customer database use but its transformational and informate features that contributed to efficiency differences.

Table 9.4.4.e Comparison of Intranet sophistication of use between the three efficiency groups

Operational efficiency in Rooms division (No. of units in efficiency group with Intranet / No. of units in efficiency group)	**Efficient** (15/16=93.75%)		**Above median** (28/39=71.79%)		**Below median** (24/38=63.15%)	
Customer Database use	N	%	N	%	N	%
Automate tasks of front and/or back office staff (1)	11	73.33	19	67.86	10	41.67
Automate tasks of sales and marketing staff (1)	12	80.00	16	57.14	13	54.17
Enable staff of different departments to access customer information (3)	11	73.33	10	35.71	9	37.50
Develop personal customised promotions and/or sales offers (3)	14	93.33	18	64.29	19	79.17
Deliver Customer Relationship Management activities (5)	10	66.67	4	14.29	1	4.17
Plan the hotel strategy (5)	8	53.33	11	39.29	1	4.17

Sophistication of use of the Website and email were not found significantly to contribute to efficiency. However, correlation coefficients between the sophistication scores of Website and email use and the percentage of roomnights from Internet (Table 9.4.4.f) revealed that the former had a significant effect on the percentage of roomnights coming from the Internet. However, when considering that the percentage of roomnights coming from the Internet was not found to significantly affect efficiency (sections 9.2.1.2, 9.2.2.2 and 9.2.3.3), it is not surprising that Website sophistication did not contribute to efficiency gains.

Table 9.4.4.f Effect of website and email sophistication of use on percentage of roomnights from the Internet

		% of roomnights from Internet
Email sophistication score	Pearson Correlation	0.004893
	Sig. (2-tailed)	*0.963286*
	N	*91*
Website sophistication score	Pearson Correlation	[redacted]
	Sig. (2-tailed)	*0.001776*
	N	*88*

[redacted] Correlation is significant at the 0.01 level (2-tailed).

Nevertheless, if the effectiveness of website is measured only by the percentage of roomnights that it contributes, then it is interesting to investigate which specific features of website lead to more roomnights and revenue. To that end, t-tests examined whether the provision or not of each website feature led to significant differences in the percentage of roomnights coming from the Internet (Table 9.4.4.g). Results indicated that hotels that provided online bookings, communicated with customers through the website and provided customised content received a significantly higher percentage of roomnights from the Internet than respondents that did not provide such website features. These findings then confirm the fact that the simple use of Internet as an advertising, promotion and information dissemination tool does not guarantee Internet reservations (e.g. Sigala, 2000 and 2001b; Evans and Wurster, 1999). For increasing Internet reservations, hotels should provide online bookings, exploit the interactive capabilities of the Internet to communicate with their customers as well as do not use the Internet to only simply gather customer information but also use it for providing customised and personalised content.

Table 9.4.4.g T-tests investigating difference in Internet reservations between hotel offering and not offering specific website features

		N	Mean	Std. Deviation	Std. Error Mean
Provide information (1)	Yes	85	3.650588	4.305689	0.467018
	No	3	0.5	0.866025	0.5
Provide links with other sites (2)	Yes	56	3.353571	3.594185	0.480293
	No	32	3.875	5.30216	0.937298
online bookings (3)	Yes	27	5.855556	5.547857	1.067686
	No	61	2.519672	3.106489	0.397745
communicate with customers (4)	Yes	57	4.557895	4.613952	0.611133
	No	31	1.677419	2.761486	0.495978
collect customer info (5)	Yes	30	4.203333	3.895044	0.711134
	No	57	3.240351	4.477717	0.593088
Provision of customised content (6)	Yes	16	5.6625	6.684497	1.671124
	No	71	3.101408	3.433261	0.407453

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1	Equal variances assumed	3.108	0.081	1.260	86.000	0.211	3.151	2.501	-1.821	8.122
	Equal variances not assumed			4.605	6.887	0.003	3.151	0.684	1.527	4.774
2	Equal variances assumed	2.763	0.100	-0.549	86.000	0.585	-0.521	0.950	-2.411	1.368
	Equal variances not assumed			-0.495	47.569	0.623	-0.521	1.053	-2.640	1.597
3	Equal variances assumed	16.495	0.000	3.604	86.000	0.001	3.336	0.926	1.496	5.176
	Equal variances not assumed			2.928	33.438	0.006	3.336	1.139	1.019	5.653
4	Equal variances assumed	8.727	0.004	3.175	86.000	0.002	2.880	0.907	1.077	4.684
	Equal variances not assumed			3.660	85.127	0.000	2.880	0.787	1.316	4.445
5	Equal variances assumed	0.000	0.994	0.996	85.000	0.322	0.963	0.967	-0.960	2.886
	Equal variances not assumed			1.040	66.669	0.302	0.963	0.926	-0.885	2.811
6	Equal variances assumed	19.732	0.000	2.206	85.000	0.030	2.561	1.161	0.253	4.869
	Equal variances not assumed			1.489	16.824	0.155	2.561	1.720	-1.071	6.193

Thus, sophistication of website use may not contribute to efficiency gains, but it does contribute to increased roomnights. Moreover, since the percentage of roomnights that respondents claimed to receive from the Internet were very low (on average 3.4%) even if Internet reservations have theoretically a potential to enhance efficiency, this may not have materialised due to the very low percentages that they represent in our sample. Thus, provided that sophistication of Website use can result in increased roomnights, it is suggested that hotels should pursue enhanced website sophistication in order to divert and/or get more reservations and roomnights from the Internet, which in turn could significantly contribute to efficiency.

Overall, it was confirmed that the automation capabilities of ICT cannot lead to enhanced efficiency gains (all hotels are doing the same). On the contrary, competition in the information age requires business to create and add value by exploiting all ICT capabilities and features. In this vein, the digital divide, i.e. the distinction between not those that have or do not have ICT but between those that do know and do not know how to exploit them, that ICT create in the hotel industry has become apparent.

9.5 Hotel ownership and management arrangement, ICT integration and sophistication of use and productivity

As it was previously found that hotel management arrangement and ownership had a significant impact on productivity levels, the reason for that was further investigated. Specifically, since the two ICT metrics namely ICT PMS integration and sophistication of use significantly affected productivity, the different types of hotels were investigated to examine whether they significantly differ in their ICT metrics. Appendix G gives the results of t-tests and ANOVA tests that were conducted in order to investigate such differences.

Regarding ICT integration the following were found. Analysis of the hotel ownership factor revealed that independent hotels have a smaller percentage of their distribution, reservation, FB and all ICT integrated to their PMS than chain owned hotels. Concerning, hotel arrangement, the ANOVA test and post hoc Scheffe tests revealed that all hotel groups attributed to significant differences apart from hotels that were members of hotel consortia which significantly differ in terms of their reservation and distribution ICT and non the FB and other ICT. However, this finding is not surprising since the main purpose of hotel consortia is for distribution and marketing.

Regarding ICT sophistication of use, results revealed that independent owned hotels had a significantly lower sophistication score than hotel chain hotels for all six critical success ICT. From post hoc Scheffee statistics it was found that membership in consortia significantly affected the sophistication of use of e-mail, which might not be surprising considering that consortia members hotels greatly use e-mail for reservations, communications etc.

Since independently owned and managed hotels had lower ICT metrics as well as lower productivity levels from hotel chain hotels that had greater ICT metrics and productivity levels, it was concluded that ICT implementation was one of the major reason that hotel chain hotels were significantly more efficient.

9.6 Conclusions

Overall, the study investigated the impact of ICT on productivity by examining the relationship between three ICT metrics and different robust measurements of productivity in terms of its type (i.e. operational, market and combined productivity) and its level (i.e. rooms and FB division productivity and hotel overall productivity). Main findings are summarised as follows:

1. Neither availability nor integration of ICT significantly affect market productivity. The impact of ICT is mainly in boosting operational efficiency. However, some exceptions of the former were found. So, GDS availability, number of distribution and reservation technologies that affect overall market efficiency and from high levels of sophistication of Customer databases that are related to greater market productivity in rooms division and in the hotel overall property.

2. In rooms division, the availability of single ICTs does not affect productivity apart from the availability of PMS, property based reservation system, customer database and F&A systems.
    a. However, this does not mean that the other ICT are not required, as it was found that operational efficiency is significantly affected by the availability of clusters of technologies, namely the number of distribution technologies and the number of reservation technologies. In other words, the productivity impact of ICT is evident and apparent when the synergy amongst ICT is taken into account. On the other hand, availability of clusters of technologies, as of single technologies, can significantly affect operational efficiency but cannot make a significant contribution to market or combined efficiency.
    b. For achieving a higher market and /or combined efficiency score hotels should more fully exploit the capabilities and features of their ICT. Indeed, as it was found, hotels that make more sophisticated use of their PMS, customer database system and Intranet have significantly greater market and combined productivity levels. It was also suggested that hotels should increase their website sophistication of use in order to divert and/or get a great number of roomnight reservations through the Internet, which in turn could lead to productivity gains.

3. In FB division, the availability of any ICT was not found to lead to productivity gains. Instead, it was only when ICT were PMS integrated that productivity gains were materialised and become apparent. Thus, systems integration in FB is more vital for productivity gains than it is in rooms division.

4. In the whole hotel property, although the availability of some ICT lead to significant higher productivity gains, these did not also have a significant productivity impact on certain hotel divisions. Indeed, from the ICT that had a significant ICT productivity impact, the availability of only PMS and F&A systems was found to affect productivity both in the hotel property as a whole and in a certain division, while, the rest ICT had a significant effect on overall operational efficiency but not in efficiency in rooms and/or FB division. In other words, ICT availability identified productivity impacts on the hotel property overall but it could not relate them to benefits in particular hotel divisions. The latter though becomes apparent when the integration of ICT is taken into consideration, because in all cases it was found that the availability of technologies significantly affected overall efficiency (i.e. productivity in both rooms and FB division) when the integration of the technology with the PMS had a significant effect on the productivity of a hotel division.
    a. Indeed, the availability of FB systems, of EPOS and stock and inventory systems did affect overall operational efficiency because hotels that had these systems integrated with the PMS had a significantly higher FB score than those that did not have the technologies integrated the PMS.
    b. In the same vein, availability of conference and banqueting systems did affect overall productivity because hotels that had these systems integrated with the PMS had a significantly higher operational efficiency score in rooms division.
    c. The availability of YM did affect overall efficiency, because hotels that had YM integrated with the PMS were more efficient in FB. This is not

surprising since by integrating YM with the PMS, the YM system provides solutions by considering data from several systems (e.g. marketing/sales systems, customer database) that are integrated with the PMS and which confirms the hypothesis regarding the implementation level of YM (Sigala et al, 2001c).

d. The availability of a telephone system does not affect efficiency but when its integration with the PMS is considered then the telephone system has a significant effect in both rooms division and overall operational efficiency. The availability of a F&A system affected both rooms and overall operational efficiency, but the latter is due again because hotels that had the F&A system integrated with the PMS had a higher efficiency score in F&B division. On the other hand, the availability of a Property Based Reservation System affected operational efficiency in rooms division but it did not affect overall efficiency since its integration with the PMS was not found to have a significant impact on efficiency.
e. To summarise, in the hotel property as a whole, only when the integration of a technology with the PMS had a significant effect on the efficiency of one hotel division (either Rooms or FB) the availability of the technology affected efficiency in the overall property. That is to say that for being efficient overall, technologies are required to be integrated with the PMS. This also justifies and confirms the theory that considers the PMS as the hotel digital nervous system and an IT platform and infrastructure that enables the efficiency potential of all other technologies.

5. The impact of ICT on particular productivity determining inputs and outputs was also investigated. Radar plot figures and statistics on the configuration of the productivity determining inputs and outputs between ICT users and non-users revealed the specific impact of ICT. These results are summarised in Table 9.4.1.4.a.

CHAPTER TEN

Conclusions, implications and recommendations for further research

10.1 Summary of findings

The main aim of this study was to investigate the productivity impact of ICT on the three star hotel sector in the UK by developing and applying a robust methodology. To achieve that, primary data were gathered and analysed in order to meet the following more precise objectives:

- To measure hotel productivity by using a robust methodology;
- To distinguish between productive and unproductive hotels while also identifying the factors constructing their productivity frontiers, i.e. the factors that affect productivity;
- To investigate the ICT systems used by hotels as well as the ways in which ICT are being implemented;
- To identify whether hotels with different ICT availability and/or implementation significantly differ in their productivity levels. Specifically, it was hypothesised that: a) hotels with integrated systems have significantly higher productivity scores; and b) hotels that make more sophisticated use of their ICT systems and capabilities have significantly higher efficiency scores. When significant differences are investigated then;
- To detect the specific productivity inputs and outputs on which ICT have an impact.

The robustness of the methodology applied is explained in detail in the methodology chapter but its major advantages are summarised as follows:

- Use of DEA in order to measure productivity by simultaneously considering all factors that affect it; in this way the aggregate productivity metric is argued to be free of any impact of any other factor and productivity differences between hotels with different ICT configurations can be attributed to the latter;
- Use of the stepwise DEA approach in order to identify and include in productivity measurement only the factors (either aggregate or break down metrics) affecting productivity; in this way the DEA constructs productivity frontiers that successfully distinguish between efficient and inefficient units, which in turn is used in order to identify the ICT productivity impact. In other words, ICT are not incorporated into productivity models as an input factor, but rather their impact on both efficient and inefficiently managed hotels is investigated and so the ICT amplifier effect is taken into consideration.
- Use of stepwise DEA in different hotel departments and use of ICT metrics at different levels; as a result analysis is undertaken at different levels of analysis in order to avoid results being obscured by aggregate metrics or of synergy effects.
- Focus on a very specific sector in order to avoid influences from contextual factors, while the productivity impact of an environmental factor namely business variability has been taken into account.
- Measurement of ICT with metrics that do not only reflect the amount of ICT investments but also the way in which ICT are being implemented and applied. To that end, a literature review has been undertaken in order to identify the ICT components and capabilities as well as to illustrate how these impact on productivity and then develop a framework for measuring ICT applications that reflect them. Consequently, the mismanagement problem of ICT is taken into consideration.

10.1.1 Productivity measurement and benchmarking across three star hotels

Results of the stepwise DEA approach in rooms division revealed that the outputs/inputs that determine the efficiency frontier in rooms division are the following: ARR; roomnights; non room revenue; front office payroll; other payroll; administration non-payroll expenses; other non payroll expenses; and the external factor of business variability. The number of rooms has also been incorporated into the DEA model and so its productivity impact is incorporated into the DEA overall productivity metric. Radar plots and statistical analysis of the configuration of inputs and outputs of three efficiency categories of hotels were conducted in order to illustrate how these factors successfully distinguish between efficient and inefficient hotels.

On the other hand, the following factors did not significantly correlate with DEA efficiency scores and so, they were not found to affect productivity: type of distribution channel used for reservations (property based system, Internet, third party); length of stay; number of full time employees; number of part time employees; number of managers and/or head of departments; number of IT staff; total number of full time staff in rooms division; full time front office staff; full time housekeeping staff; full time administration staff; full time marketing staff; full time minor operations staff; proportion of total hotel payroll paid for full time staff; front office material and other expenses; housekeeping payroll; housekeeping material and other expenses; telephone expenses; telephone material and other expenses; minor operations payroll; minor operations material and other expenses; administration payroll; marketing payroll; marketing material and other expenses; expenses on IT training; percentage of roomnights from repeat customers; percentage of roomnights per market segment (business, leisure, conference).

In the FB division, the stepwise approach identified the following inputs/outputs to affect productivity: total FB capacity (restaurant seats plus banqueting capacity), FB revenue, FB payroll, FB non-payroll expenses (material and other expenses), business variability and the percentage of banqueting to restaurant covers served. Again, radar plots and statistical analysis of inputs/outputs configuration were carried out in order to illustrate how these factors effectively construct robust productivity frontiers.

On the other hand, the following factors were not found to have a significant impact on efficiency, since no significant correlations were found between them and the efficiency score: roomnights from repeat customers; roomnights per market segment (business, leisure, conference); occupancy; roomnights; number of full time FB staff; proportion of total hotel payroll for full time staff; total expenses for training on IT; number of restaurant covers served; revenue orientation of hotel (i.e. percentage of FB revenue to total hotel revenue).

Consequently, inputs and outputs affecting productivity in the whole hotel property were the following: ARR; roomnights; non room revenue, FB revenue, number of rooms; total FB capacity; front office payroll; administration and general expenses; FB payroll, FB material and other; other payroll, other material and other expenses; business variability. On the other hand, the following factor were not found to affect hotel overall productivity: percentage of roomnights from repeat customers; percentage of roomnights per market segment (business, leisure, conference);

percentage of reservations per distribution channel (property based, third party and Internet); length of stay; proportion of total hotel payroll for full time staff; number of full time staff; number of managers and/or head of departments; number of IT staff; number of full time staff in front office, housekeeping, FB, telephone, administration, marketing, minor operations, maintenance; front office non payroll (material and other) expenses; housekeeping expenses (payroll and non-payroll); telephone expenses (payroll and non payroll); minor operations expenses (payroll and non payroll); administration payroll expenses; marketing expenses (payroll and non payroll); maintenance expenses (payroll and non payroll); energy expenses; total expenses for IT training; and management fee expenses.

As productivity in rooms and FB division as well as in the whole hotel property was significantly affected by the business variability factor, analyses were undertaken in order to incorporate its impact on productivity by distinguishing and measuring three types of productivity levels namely operational, market and combined efficiency. In this way, productivity measurement distinguishes and measures the productivity impact of business variability separately (i.e. market and/or operational efficiency only) and within operations management (i.e. combined efficiency). The measurement of different types of productivity is crucial since different ICT and their applications may impact differently on different productivity dimensions.

10.1.2 Implementation of ICT and its impact on productivity

Data regarding three metrics reflecting ICT investments and applications that the literature identified to significantly affect productivity were gathered and investigated on their ability to identify and measure a productivity impact. Descriptive analysis of these data revealed that: 1) a wide system of ICT is being adopted by three star hotel companies; 2) ICT are being adopted in different rates, while despite their importance not all six critical success ICT are widely available in all hotel properties; 3) a relatively big gap is found between adoption and PMS integration levels of ICT, meaning that hotels have been mainly implementing ICT investments in a piecemeal approach, which can in turn significantly affect their ability to boost productivity beyond automation and task isolated benefits and to materialise synergy effects; 4) the sophistication levels of use of the six critical success ICT are quite low, meaning that the majority of hotels are still at the first stages/eras of ICT implementation failing to fully exploit ICT capabilities and tools to boost productivity gains.

Statistical tests investigating the impact of the three ICT metrics on productivity confirmed the arguments found in the literature regarding the following: 1) ICT metrics reflecting the amount of ICT investments cannot effectively identify and assess productivity benefits and so can lead to conclusions illustrating an ICT productivity paradox; 2) when the integration of ICT is taken into account, productivity benefits are more clearly identifiable; and 3) as it is not the ICT per se but rather how they are being used that leads to productivity gains, results confirmed that a full exploitation of the network, communication and information capabilities and tools of ICT that goes beyond the application of ICT in automating isolated and canned processes can lead to enhanced productivity benefits. These conclusions derive from the following findings.

First, ICT availability was investigated in its impact on productivity in the two hotel divisions and the hotel property as a whole. Concerning the ICT productivity impact on rooms division the availability of only six ICT was found significantly to affect operational efficiency namely, PMS, Customer Database, Property based reservation system, Front Office system, Finance & Accounting systems, Stock & Inventory systems. The availability of an Intranet significantly affected market efficiency, while the availability of Stock & Inventory systems, in-room Internet & e-mail access and on-demand movies significantly affected combined efficiency. On the contrary, availability of any single distribution, reservation or in-room ICT did not significantly impact either on operational or market efficiency.

Interestingly, in the FB division the availability of none of the FB ICT affected productivity. An exception is that hotels with automated mini-bars and videoconferencing systems availability had a significantly higher FB efficiency score than hotels without such availability.

From the 11 ICT that significantly affected efficiency in the two hotel divisions only four of them were also found to have a significant effect on the efficiency of the hotel property as a whole, namely PMS, F&A, Stock and Inventory and videoconferencing systems, whose holders accounted for higher operational efficiencies. Moreover, the availability of YM, Conference & Banqueting, F&B systems, EPOS, electronic lock and Energy Management systems also contributed to higher operational efficiencies, while the availability of GDS and FB systems resulted in higher market efficiencies.

Statistical analysis and radar plot figures were carried out in order to identify and illustrate the productivity impact of these ICT on specific inputs and outputs. Such results may suggest that ICT availability is not worthwhile since a productivity impact is not clearly made evident. For example, a hotel may decide not to invest in a distribution ICT or an FB ICT since no gains were evident. However, further analysis illustrated that such a decision might have been wrong. Indeed, when the synergy effect across ICT is taken into account as well as their integration and level of sophistication of use, it becomes evident that hotels having higher levels of these ICT metrics clearly outperform others.

Indeed, it was found that although the availability of single ICT does not significantly affect productivity, hotels with greater number of reservation, distribution, general and rooms ICT significantly outperform those with fewer ICT. In this vein, investment decisions on ICT should take into consideration the impact that a single ICT can foster or enable within a system of other related technologies. Thus, the integration and co-ordination of any ICT with other technologies and other tasks within the same process become crucially important. This was also confirmed when the productivity impact of the integration of ICT was investigated. Specifically, it was found that in almost all cases when the availability of a single or a cluster of ICT had a significant productivity impact, that was because hotels that had the ICT and had them integrated with their PMS differ significantly from hotels that did not have the ICT at all. Hotels that reported only ICT availability did not statistically significantly differ from the previous two groups of hotels, meaning that it is the PMS integration that enables and fosters enhanced productivity gains. The integration productivity impact is crucially important in the FB division whereby the availability of neither single or cluster of ICT affected productivity but integration did.

Systems integration was also found to be important in terms of fostering and enabling synergy productivity impacts between hotel divisions. So for example, integrated YM systems can lead to enhanced performance not only in rooms division but also in FB, as systems integration supports information dissemination from FB to sales department which in turn can identify, target and customise rooms rates to the most profitable customers. In the same vein, videoconferencing systems were also found to result to increased productivity levels in both FB (e.g. FB revenue) and rooms division (e.g. occupancy) as the availability of videoconferencing systems brought a new source of business for the hotels.

Although the literature indicated that the availability of six ICT is critical in the hotel industry, neither the availability of a greater number of critical success ICT nor their PMS integration was able to identify a significant productivity impact. However, statistically significant productivity differences were found when the level of sophistication of ICT was taken into consideration. Indeed, hotels that made more sophisticated use (greater sophistication scores) of their PMS, customer database and Intranet systems clearly outperform others. Indeed, further statistical tests (chi-squares) confirmed that it was not the automation activities but the informational and transformational that can lead to significant productivity gains. Such findings more strongly confirmed that in the knowledge and digital era a clear distinction is made not between "have" and "not have" of ICT but those that know and do not know how to apply ICT.

As independent and hotel chain managed hotels were found to differ significantly in the three ICT metrics, it was argued that productivity differences found between these two groups can be attributed to a great extent to the different implementation and application of ICT.

Finally, it was illustrated that ICT can have a significant impact on operational and combined productivity however, their impact on enhancing market productivity per se is very limited (apart from certain reservation and distribution ICT). In other words, as the way productivity is measured can also affect results, conclusions of previous studies investigating the productivity impact may have also been diluted by the fact that it was not clear what the productivity metrics that have been used measured and included.

Combining the research findings with the theory of Performance Frontiers the following conclusions derive:

- The asset frontier (i.e. the amount of ICT assets/resources) did very little in explaining productivity differences;
- The operating frontier (i.e. the operating processing of exploiting and using ICT) provided more significant evidence for productivity differences among hotels.

Thus, after locating hotels in the operating and asset frontier relative to their competitors, the following productivity improvement strategies are proposed. Hotels that are placed far from the asset frontier need to invest in ICT, extend their asset frontier and then try to shift their operating frontier closer to their asset frontier by more fully exploiting ICT tools and capabilities. On the other hand, hotels located at and with the same asset frontier can achieve greater productivity gains by moving their operating frontier (i.e. the way they exploit ICT) closer to their asset frontier, instead of investing in more ICT in order to extend their asset frontier.

10.2 Implications

The study is argued to be of great value to both the academic and professional circles within the hospitality and tourism sector as well as within other business sectors in general. This is because of the following.

First, by developing and following a robust methodology, this study clearly demonstrated that ICT can clearly result in enhanced productivity results. In this vein, the contradictory and inconsistent results of previous studies can be attributed to the methodological problems that this study claims to overcome. That is to say that the ICT productivity paradox has been a methodological and/or a statistical artefact and this study tried to overcome such limitations and shortcomings. To that end, in investigating the ICT productivity paradox this study did not only attempt to answer the question whether ICT results in productivity gains or not but also to examine the following question: "how ICT can theoretically be so productive and their great potential can or cannot be captured and materialised?".

As a result, the study did not only illustrate the vital importance of ICT in gaining increased productivity levels, but it also identified the specific issues and concerns of ICT that should be taken into account if ICT benefits are to be materialised. The ability to identify particular ICT applications and their benefits is of a particular value because it allows businesses to develop their ICT portfolio in alignment with their business strategy fulfilling the following main purposes:

- Surviving and functioning as a business;
- Improving business performance by cost reduction/increasing sales;
- Achieving a competitive leap;
- Enabling the benefits of other ICT investments to be realised;
- Being prepared to compete effectively in the future.

Specifically, it was confirmed that simple ICT availability cannot lead to increased performance. On the contrary, issues that any business should take into consideration are the following:

- Systems integration for developing an electronic infrastructure or a digital nervous system that can support and enable the development and materialisation of the benefits of other ICT applications; in the case of hotels the PMS plays a central role, however Internet based applications such as the Intranet were found increasingly to play such a role due to their standardised technology (HTTP, XML ext) that can easily enable the plug and play of "webified" applications. The latter are significantly increasing in the hotel sector as a result of the boom of the ASP sector and the migration of most hotel ICT suppliers on the Internet.
- The collection, analysis, dissemination and use of information collected by ICT. Systems integration plays an important role in information dissemination but information should be increasingly filtered and used by key players in order to personalise products/services and customers' experience.
- Innovate use of ICT in order to transform existing operating paradigms. ICT ability is not limited to their ability to support business operations and strategies, ICT can also foster and create new operations and strategies that can differentiate companies from competitors and give them a competitive leap.

In other words, the materialisation of the ICT benefits is not an ICT problem but rather a business problem. ICT management should be integrated into and aligned with business operations and strategy. However, to achieve these, a more sophisticated approach to ICT is required. So, for example, for ICT projects that move beyond simple work automation, sound IT project management is required, e.g. workers may need to learn new skills, assume new responsibilities and accept different reward systems. As ICT become more sophisticated, the challenge of training the industry's personnel is growing exponentially. By contrast, respondents of this study reported significantly very low expenses for and commitment to ICT training provision, which is not contradictory with the fact that only few respondents reported ICT use beyond the automation stage.

Thus, although such changes in management practices are as necessary and important as ICT, there has been a lag in management practices and thinking as concerns the successful implementation of ICT applications. In fact, it can be argued that there is a persistence of the industrial age mind set about the capabilities of ICT and more specifically about the power of ICT alone to deliver business results. Thorp (1994, p. 21) called this the *"silver bullet thinking"*, a concept illustrating the idea that all management has to do is to plug in the technology and magically the benefits will flow.

On the contrary, research findings indicated that materialising ICT benefits is much more than "plug and play" thinking. Thus, the need of a framework or model that would illustrate and consolidate the issues and their relationships that ICT management requires is made evident. However, in reviewing the literature, it was made evident that ICT management still struggles in its identity. Indeed, Lewis et al (1995) provided a good survey of the manifested confusion. Maes (1999) also argued that the lack of a common accepted precise notion of ICT management had significantly inhibited an accurate empirical testing of the contribution of ICT to the success of organisations.

In this vein, in investigating the productivity impact of ICT, the study had a second objective to make a real contribution to the general literature and science and to extend its scope to the fourth type of hospitality research by making its results and implications relevant and valuable to circles beyond that of the hospitality and tourism field. In this vein, research findings demonstrating a relationship between ICT and organisational productivity are claimed to identify the ICT components and issues that need to be managed in order to ensure productivity gains and so need to be included in an ICT management framework. These components are: 1) business processes; 2) information; 3) information systems; and 4) technology infrastructure.

The business processes consist of communicating and collaborating people in the role of employee and of organisational units such as teams or departments. The business processes are organised as one or more supply chain of individuals, organisational units and companies working together in delivering products or services to the customers. The environment of a company is seen as a network or else as a value system connecting the company with customers, suppliers and third parties. The business processes component is included in order to reflect arguments (e.g. Venkatraman and Henderson, 1989) regarding the required alignment between the business and ICT field. In other words, businesses need to investigate how ICT can be applied in their processes in order, for example, to: streamline processes; automate or obliterate non value added activities; co-ordinate teams of employees and tasks; link business with suppliers, customers and partners. This is because ICT do not have value in themselves but they provide value through the business processes that they are applied.

The information component was also found to be a vital enabler of productivity gains. The business value of information can be varied and diverse. The people in the business processes are supported by an information provision system, which enables the business processes by supporting the creation, processing, exchange, storage and use of information and knowledge. The information provision in fact acts as the collective memory and frame of reference of the business. Information is also important for customising and personalising business products and services. The consideration of the information element is important because, as several authors argued, the importance of technological aspects has been overemphasised to the detriment of infological aspects (e.g. Davenport, 1994; Strassmann, 1998). Olsen (2000, p. 30) also argued that *"technology has become a major force in the operation of hospitality businesses. The convergence of technological applications places knowledge and information at the core of the competitive profile of tomorrow's hospitality enterprise"*. In this vein, the competitive marketplace of the "information age" will require hotels to build their success on how much they know about their customers, how they will provide them with information about their products and services, and how they will profitably distribute products/services in an information-based environment.

The information systems component is included in order to reflect the increasing importance of systems integration that enables communication and networking capabilities. It encompasses a network of communicating and co-operating software that deliver (automated, seamless) services to the people that have a business process role and/or an information role. These automated services enable the communication and control in the business processes and the creation, processing, exchange, storage and use of information and knowledge in information provision. Unfortunately, the importance of "communication" has only recently been widely recognised (Maes, 1999) and it is illustrative that the term "information and communication technologies" is increasingly replacing the well established term "information technology".

The technology infrastructure is seen as a network of communicating and co-operating hardware devices, system software and netware and/or middleware (e.g. Pegasus, WiZcom, ERP systems, PMS). The Technology Infrastructure (TI) delivers processing, communication and storage capabilities to the information systems and human/computer interfaces to the people in business processes.

All these four components need to be managed in an integrated and co-ordinated way. So, for example, the management of a hotel Website should consider the following:

- business processes; automation of reservation/booking process, online registration/access to the customer database etc. If these are provided how will the booking process be streamlined, what tasks need to be automated and obliterated, which staff/tasks will become redundant and what skills/roles employees should now possess?

- information: what kind of information should be provided on the Website? Where does it exist/ is stored at the moment (is systems integration required)? How will it be updated (manually or seamless, the latter would require systems integration); what kind of customer information will be gathered, where will it be stored, how will it be used? How information sharing and use will be facilitated and motivated?
- information systems. If ICT are to co-ordinate tasks/people what systems integration is required? How integration can be achieved?
- technology infrastructure. What hardware, software and netware will support and enable such website applications identified in the business processes domain?

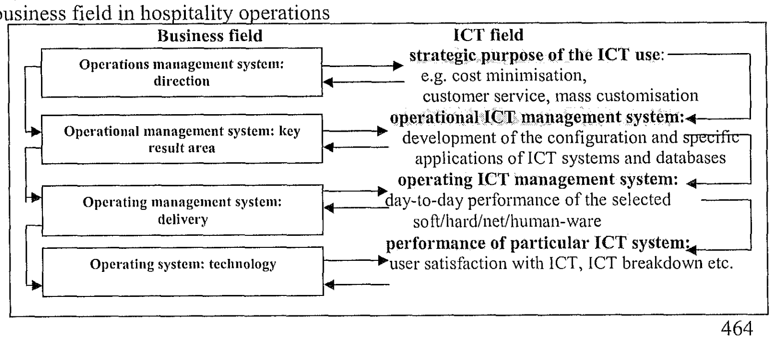
Moreover, as it has been argued that productivity should include both effectiveness (i.e. do the right things) as well as efficiency (do things right), in order to result in productivity gains the four ICT management areas need to be managed at four organisational levels namely, strategy, operational, operating management system and operating system level. These levels are adopted from Jones and Lockwood's (1995, p. 19) framework of productivity that recognised that productivity gains or differences can be due to wrong decisions or implementation at these four levels. In other words, ICT are recognised as an organisational resource that needs to be managed in a systems approach along with other organisational resources if ICT benefits are to materialise.

The applications of systems thinking in the management of ICT and the materialisation of their productivity gains is helpful because it identifies:

- the inputs and outputs that should be measured and managed at each level;
- the links between the activities and decisions at each level while recognising that ICT benefits at higher levels are affected by performance of activities at lower levels and vice versa;
- how ICT is embedded into organisational activities and how ICT management should be integrated with concepts and issues in the business field;
- that ICT is a resource that has to be managed along with other business resources and that its value is materialised when it is embedded with organisational processes and activities.

These arguments are illustrated in Figure 10.2.a, which tries to identify how the communication and control principles of system thinking (Jones and Lockwood, 1995) are applied in the ICT systemic approach of management.

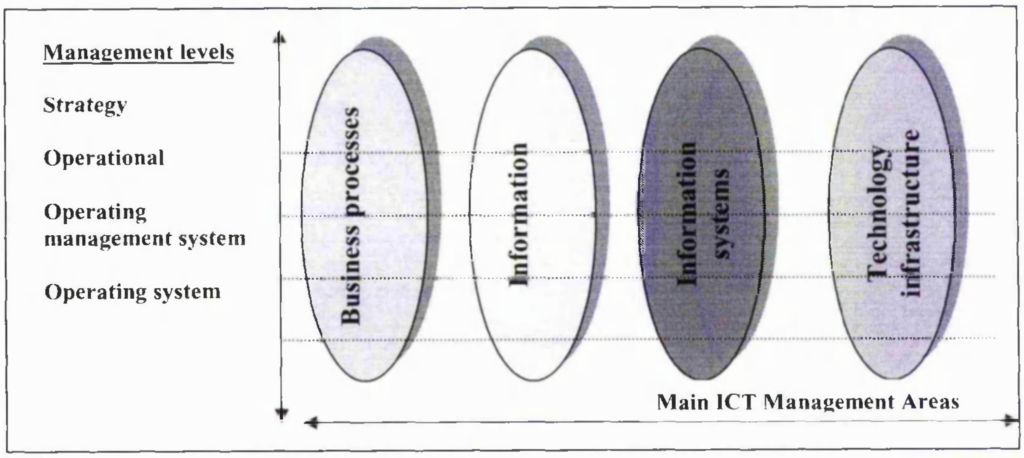
Figure 10.2.a Systemic Management of ICT resources and their integration in the business field in hospitality operations



In summary, this figure clearly illustrates that in order to deliver business value, hotels should have a strategic direction, goals and purpose, on the use of ICT (level 1), which will be translated into specific ICT applications, whose configuration should enable and support their implementation (level 2). Results of these two levels also depend on the day-to-day performance of ICT resources and users. In this vein, lack of ICT productivity benefits may be due to any combination of the following four reasons: 1) wrong direction of ICT strategic use; 2) wrong specification and configuration of ICT applications/systems/databases; 3) wrong day-to-day use of specified ICT applications; and 4) ICT failure to perform. Thus, the essence of such a systemic analysis is that the key to enhanced performance is that hotels have to do the right things and they have to do them right.

Finally, Figure 10.2.b summarises the previous two issues (i.e. components of ICT and their level of management) in order to provide an overall framework of ICT management.

Figure 10.2.b Framework of ICT management



However, research findings and their implications in developing this framework raise more questions and issues for further research.

10.3 Limitations of the study

An honest evaluation of any study should also mention its limitations and constraints. And as any piece of work, this study faces some constraints. The major limitation of research findings refers to the small number of respondents and sample size. Unfortunately, due to time and sources constraints the study was focused on the three star hotel sector, while the sensitivity of the data required from respondents also created difficulties in gathering data and achieving a high response rate. To ameliorate the latter, personal contacts were used while care was taken in order to achieve a representative sample by including different types of hotels i.e. independent, consortia and hotel chain hotels. However, one could argue that sample may be biased on the basis that hotels from only one consortium and hotel chain outweigh the research sample.

Thus, overall, two major issues characterise the sample of this study: the comparatively small size of the sample (93 three star hotels); and the spread of respondents from the three star hotel sector in the UK, with an emphasis on one hotel chain and one consortium. Although the consortium represents a wide range of three star hotels in the UK (by size, ownership structure, location etc), because of the previous issues the research findings are constrained from generalisation. In other words, it is not possible to generalise the conclusions of the study for the whole hotel sector in the UK, or with confidence for the three star hotel sector as a whole. Sample representativeness and bias would only be crucial when the research question was to investigate whether investments and use of ICT had any impact on the productivity of the (three star) hotel sector in UK or whether (three star) hotels in UK exploit ICT to improve their productivity. However, that was not the major aim of this research. This research's key aim was to investigate and test the validity of the ICT productivity paradox; that is to say, whether ICT does have or does not have an impact on productivity. These two research questions are different and should not be confused specifically when the findings of this study are interpreted. Having said that, although the validity of previous studies investigating the productivity paradox has been criticised on methodological grounds, the validity and robustness of the methodology used in this study is strongly illustrated and advocated. By using a robust methodology, the research findings presented here unravel the productivity paradox as they provide positive evidence of the impact that ICT can have on productivity. Indeed, that is one of the major contributions of this study; i.e. the development and testing of a robust methodology for investigating the ICT productivity paradox. Future research could use this methodology in other sectors or with other datasets to provide more conclusive results regarding the first question e.g. on whether the use of ICT has any impact on the productivity of the banking/insurance/restaurant sector.

The study was also confined and limited on the theoretical backgrounds and knowledge upon which it could have been built and developed. Specifically, although a great body of research has investigated the ICT productivity impact, previous studies have been criticised on their methodology, a consolidated and widely accepted theory on how ICT impact productivity does not exist, while productivity measurement and improvement body of knowledge also represent some gaps and limitations. To that end, after reviewing existing literature and research, the study had to start by developing a methodology for examining the ICT productivity paradox that would overcome previous limitations and that would enhance the body of knowledge on how ICT impacts productivity and so they can be best managed to achieve organisational benefits. In this vein, the study is valuable as, by applying a sound methodology, it provides a positive evidence of the ICT productivity impact and the ICT components affecting productivity. So, although the study did not investigate and examine factors and soft issues of ICT management that are required for achieving organisational benefits, its findings are important for providing the basis and the variables that future research into the management of ICT for the delivery of business value should take into consideration.

10.4 Recommendations for further research

Although the study identified and provided evidence of the productivity impact of the major ICT management components namely information, systems integration and architecture some critical questions regarding how the implementation and management of these components should be done arise. Such questions can include the following:

- How do organisations successfully integrate ICT with their processes, operations and strategy? Is it the case of a bottom-up and/or top-down approach, or not?
- How the ICT led process re-engineering and restructuring can be effectively managed in order to materialise its benefits?
- How business support and motivate staff to collect, share and use information?
- What are the specific information literacy skills and competencies that are required and how can they be developed and enhanced?
- What kind of organisational culture should be developed in order to support such organisational and ICT infrastructures?
- What is the role of staff reward/appraisal systems in this process?

To answer these soft issues, a second stage of qualitative research is required. One of the advantages of the DEA benchmarking analysis conducted in this study is that it identified outperforming hotel properties that can be further investigated in more detail on how they are specifically manage these ICT components to achieve enhanced productivity gains. An important issue to be considered in such second stage research is the people issue and their role in the successful transfer/adoption of ICT and so the materialisation of any ICT productivity benefits. The importance of people has been stressed by several authors. For example, Gretzel (2000) highlighted the importance of organisational capacity to change for effective use of ICT, Kirk (1995) advocated the combined use of hard and soft systems for project planning and specifically for IT implementation in the hospitality industry, since decisions need to be taken within a socio-technical system whereby the needs of decision makers are taken into consideration. Indeed, Clark's (1994) study on the impact of IT on hospital food service technical systems proved the effect of soft issues on productivity improvements. Research conducted by Pine (1985) investigating the use of IT in the UK catering industry as well as technology transfer in the international hotel industry (Pine, 1991) proved that people involved in the process are the most crucial factor for technology success. In reviewing research in hospitality systems and technology, Kirk and Pine (1998) concluded that the productivity paradox of ICT can be resolved if all people involved in the process are taken into account, i.e. both employees and customers. Jones (1990) also argued that the success of productivity improvement techniques in general can vary on the basis of formal and informal criteria that organisations take. Formal criteria include the structure of the organisation, delegation and authority, cost allocation, remuneration policy and other aspects of the organisation over which planning and control can be exercised. Informal criteria such as organisational climate and culture, involvement strategies, decision-making processes and people development support productivity improvement by changing informal ideas, attitudes and behaviour rather than organisations.

Moreover, one limitation of the study is that although it argued that productivity is comprised and affected by different dimensions i.e. effectiveness, efficiency, quality, the way that productivity was measured and then related to ICT metrics did not allow the identification of the impact of ICT on these particular aspects of productivity. Instead, productivity was measured by aggregate, financial metrics in order to incorporate all productivity dimensions and so, the question of whether hotels have managed to use ICT in order to enhance all, part or neither of the productivity dimensions is not answered. Moreover, as the proposed ICT management framework demonstrates, the materialisation of ICT benefits is dependent on decisions and/or implementation of activities at four different levels.

In this vein, once the study proved that ICT do have a productivity impact (by applying a robust and reliable framework that is claimed to overcome the methodological problems of previous studies on the ICT productivity paradox), further research could focus on investigating what is the impact of ICT on specific levels of productivity, e.g. strategic performance, operational performance, individual productivity, service quality etc., as well as how productivity at each level affects or relates with performance in other levels. Moreover, as the study identified four components of ICT that should be managed in order to provide benefits, the impact of these components and their interrelationships on specific productivity dimensions should be taken into consideration and examined. Furthermore, factors affecting the management of each component to materialise impacts should also be identified.

Overall, above all, this research is important and valuable because:

- It provides a sound methodology for investigating the ICT productivity paradox that overcomes the limitation of previous research;
- It extends the body of knowledge of how ICT impact productivity;
- It provides evidence of the positive impact of ICT on productivity, an issue that has engaged research for several years;
- It develops a systematic way of measuring productivity, which identifies the factors determining the productivity frontiers and so the areas that need improvement;
- It identifies the ICT components as well as their applications that affect productivity and by summarising them into an ICT management framework it outlines the factors that businesses need to manage and co-ordinate in order to maximize organisational benefits from their ICT investments;
- It provides the basis and variables upon which future research can be built.

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Appendices

APPENDIX A

The mathematical model of DEA

DEA is a linear programming model that attempts to maximise a service unit's efficiency, expressed as a ratio of outputs to inputs, by comparing a particular unit's efficiency with the performance of a group of similar service units that are delivering the same service.

The DEA linear programming model is formulated as follows.

Definitions of variables

Let E_k, with $k = 1, 2, \ldots, k$, be the efficiency ratio of unit k, where k is the total number of units being evaluated.

Let u_j, with $j = 1, 2, \ldots M$, be a coefficient for output j, where M is the total number of output types being considered. The variable u_j is a measure of the relative decrease in efficiency with each unit reduction of output value.

Let v_i, with $i = 1, 2, \ldots, N$, be a coefficient for input i, where N is the total number of input types being considered. The variable v_i is a measure of the relative increase in efficiency with each unit reduction of input value.

Let O_{jk} be the number of observed units of output j generated by service unit k during one time period.

Let I_{ik} be the number of actual units of input i used by service unit k during one time period.

Objective function

The objective is to find the set of coefficient u's associated with each output and of v's associated with each input that will give the service unit being evaluated the highest possible efficiency.

$$\text{Max } E_e = u_1 O_{1e} + u_2O_{2e} + \ldots + u_MO_{Me} / v_1I_{1e} + v_2I_{2e} + \ldots + V_NI_{Ne}$$

Where e is the index of the unit being evaluated.

This function is subject to constraint that when the same set of input and output coefficients (u_j's and v_i's) is applied to all other service units being compared, no service unit will exceed 100 percent efficiency or a ratio of 1.0.

Constraints

$$u_1 O_{1k} + u_2O_{2k} + \ldots + u_MO_{Mk} / v_1I_{1k} + v_2I_{2k} + \ldots + V_NI_{Nk} \leq 1.0 \quad (2)$$

$k= 1,2, \ldots, K$

To solve this fractional linear programming model using standard linear programming software requires a reformulation. Note that both the objective function and all constraints are ratios rather than linear functions. The objective function in equation (1) is restated as a linear function by arbitrary scaling the inputs for the unit under evaluation to a sum of 1.0.

$$\text{Max } E_e = u_1 O_{1e} + u_2O_{2e} + \ldots + u_MO_{Me}$$

Subject to the constrain that $v_1I_{1e} + v_2I_{2e} + \ldots + V_NI_{Ne} = 1$

For each service unit, the constraints in equation (2) are similarly reformulated;

$$u_1 O_{1k} + u_2O_{2k} + \ldots + u_MO_{Mk} - (v_1I_{1k} + v_2I_{2k} + \ldots + V_NI_{Nk}) \leq 0 \quad , k = 1,2, .., K$$

where $u_j \geq 0$ $j= 1, 2, .., M$ and $v_i \geq 0$ $i = 1,2,3, \ldots N$

A question of sample size often is raised concerning the number of service units that are required compared with the number of inputs and outputs selected in the analysis.

Appendix B
Minimum facilities and services for each hotel star classification (AA hotel guide, 1999, p. 6)

- *One star hotels;* hotels in this classification are likely to be small and independently owned, with a family atmosphere. Services may be provided by the owner and family on an informal basis. There may be a limited range of facilities and meals may be fairly simple. Lunch, for example, may not be served. Some bedrooms may not have en-suite bath/shower rooms. Maintenance, cleanliness and comfort should, however, always be of an acceptable standard;
- *Two star hotels;* in this classification hotels will be typically small to medium sized and offer more extensive facilities than at the one star level. Some business hotels come into the two star classification and guests can expect comfortable, well-equipped, overnight accommodation, usually with an en-suite bath/shower room. Reception and other staff will aim for a more professional presentation than at the one star level, and offer a wider range of straightforward services, including food and drink;
- *Three star hotels;* at this level, hotels are usually of a size to support higher staffing levels, and a significantly greater quality and range of facilities than at the lower star classifications. Reception and the other public rooms will be more spacious and the restaurant will normally also cater for non-residents. All bedrooms will have fully en-suite bath and shower rooms and offer a good standard of comfort and equipment, such as hair dryer, direct dial phone, toiletries in the bathroom. Some room service can be expected and some provision for business travellers;
- *Four star hotels;* expectations at this level include a degree of luxury as well as quality in the furnishings, décor and equipment, in every area of the hotel. Bedrooms will also usually offer more space than at the lower star levels, and well designed, co-ordinated furnishings and décor. The en-suite bathrooms will have both bath and fixed shower. There will be a high enough ratio of staff to guests to provide services like porterage, 24-hour room service, laundry and dry-cleaning. The restaurant will demonstrate a serious approach to its cuisine.
- *Five star hotels;* in this category hotels have spacious and luxurious accommodation throughout the property. Interior design impresses with its quality and attention to detail, comfort and elegance. Furnishings should be immaculate. Services should be formal, well supervised and flawless in attention to guests' needs, without being intrusive. The restaurant will demonstrate a high level of technical skill, producing dishes to the highest international standards. Staff are knowledgeable, helpful, well versed in all aspects of customer care, combining efficiency with courtesy.

Appendix C
Research instrument: survey questionnaire

INVESTIGATING THE RELATIONSHIP BETWEEN THE USE OF INFORMATION TECHNOLOGY (IT) AND HOTEL PRODUCTIVITY

Characteristics of the hotel business

A. This section is concerned with the characteristics of your hotel business. Please answer all the questions by placing a tick (√) in the appropriate box and by completing the following tables.

1. Where is your hotel located?

Rural ☐ City Centre ☐ Suburban ☐

2. How best would you characterise the design of your hotel building?

Old and/or traditional ☐ Redesigned/converted ☐ Purpose built ☐

3. What is the ownership structure of your hotel business?

Independently owned ☐ Chain owned ☐

4. What is the management arrangement of your hotel business?

Independent management ☐ Chain management ☐

Independent and consortia membership ☐ Franchise ☐

5. How much does your business vary over the year?

Greatly ☐ Somewhat ☐ Not at all ☐

6. How much does your business vary over the week?

Greatly ☐ Somewhat ☐ Not at all ☐

7. What proportion of your guests, approximately, are repeat customers?

......................%

8. What percentage (%), approximately, of total roomnights did each of the following sources represent in your hotel during 1999?

Business travellers	%
Leisure travellers	%
Conference	%
Other	%
Total	**100%**

9. What percentage (%), approximately, of total roomnights were received by each of the following systems/channels during 1999?

Property owned system, e.g. telephone, fax	%
Third parties, e.g. travel agents, GDSs	%
Internet, e.g. E-mail, WWW	%
Total	**100%**

HOTEL STATISTICS

B. This section is concerned with statistics of your hotel business. All data should be for a financial year ending during 1999. Please answer the questions by completing out the tables.

1. ROOM AND RESTAURANT STATISTICS

What is the hotel capacity in terms of:			
Rooms		Bedspaces/sleepers	
Maximum banquet capacity	Covers	Restaurant seats	
What were (approximately) the following annual achieved statistics of your hotel?			
Average annual room occupancy	%	Average length of stay	days
Average room rate	£	Restaurant covers	
Roomnights		Banquet covers	

2. EMPLOYEE STATISTICS

What is the number staff employed at your hotel as:			
Full-time employees		Part-time employees	
What is the number of staff employed at your hotel as:			
Information Technology technicians (full and/or part time)		Managers and/or heads of department	
How many full-time employees work in the following departments?			
Front Office		Housekeeping	
Food & Beverage		Telephone/switchboard	
Administrative & General		Sales & Marketing	
Minor Operations, (e.g. valet, pool, gym)		Maintenance	
Other			
What proportion of last year' s total payroll expenses was for full time staff?......%			

3. PROFIT & REVENUE STATISTICS (including VAT)

What was the hotel's annual profit before fixed charges? (000s)			£...........
What was the hotel's annual revenue? (000s)			£...........
What percentage of that revenue came from each of the following departments?			
Rooms division		Food & Beverage	
Minor Operations, (e.g. valet, pool, gym)		Telephone/switchboard	

4. EXPENSE STATISTICS

Please complete the Table by giving (approximately) the expenses that are appropriate and applicable to your hotel.
Figures should be for the last financial year and in 000s.

	Direct material expenses	Payroll and related expenses	Other expenses
Front Office			
Housekeeping			
Food & Beverage			
Telephone/switchboard			
Minor Operations, (e.g. valet, pool, gym)			
Administrative & General			
Marketing			
Maintenance			
Energy expenses			
Management Fees			
Training on Information Technology			
Other			
TOTAL HOTEL'S EXPENSES			

INFORMATION AND COMMUNICATION TECHNOLOGY SYSTEMS AND APPLICATIONS

C. This section is concerned with the use and configuration of any Information and Communication Technology (ICT) applied at your hotel property.

1. Does your hotel have a Property Management System (PMS)? **Yes** □ **No** □

If Yes, then, what is it used for? Please tick (√) all applicable boxes.

Automate front office operations	
Automate back office operations	
Communicate and share information between departments	
Collect and store data	
Analyse data and/or produce reports	
Create a platform that supports other applications	
Other (Please specify)	

2. Does your hotel have a Web site? **Yes** □ **No** □

If Yes, then, what is it used for? Please tick (√) all the applicable boxes.

Provide information, e.g. on the hotel property, job vacancies, special offers	
Provide links to other sites	
Provide real time, on line bookings	
Communicate with customers	
Collect customer information	
Provide customised content, e.g. customised deals, access to loyalty program	
Other (Please specify)	

3. Does your hotel have the following technologies?

E-mail **Yes** □ **No** □

Intranet **Yes** □ **No** □

Extranet **Yes** □ **No** □

If Yes, then, what are they used for? Please tick (√) all the applicable boxes.

	E-Mail	Intranet	Extranet
Automate front office operations			
Automate back office operations			
Store information, e.g. hotel policies, application forms			
Make room reservations and bookings			
Conduct transactions with suppliers			
Enable internal communication and/or co-operation			
Enable external communication, e.g. with suppliers			
Other (Please specify)			

4. Does your hotel have a Customer Database/Warehouse? **Yes** □ **No** □

If Yes, then, what is it used for? Please tick (√) all the applicable boxes.

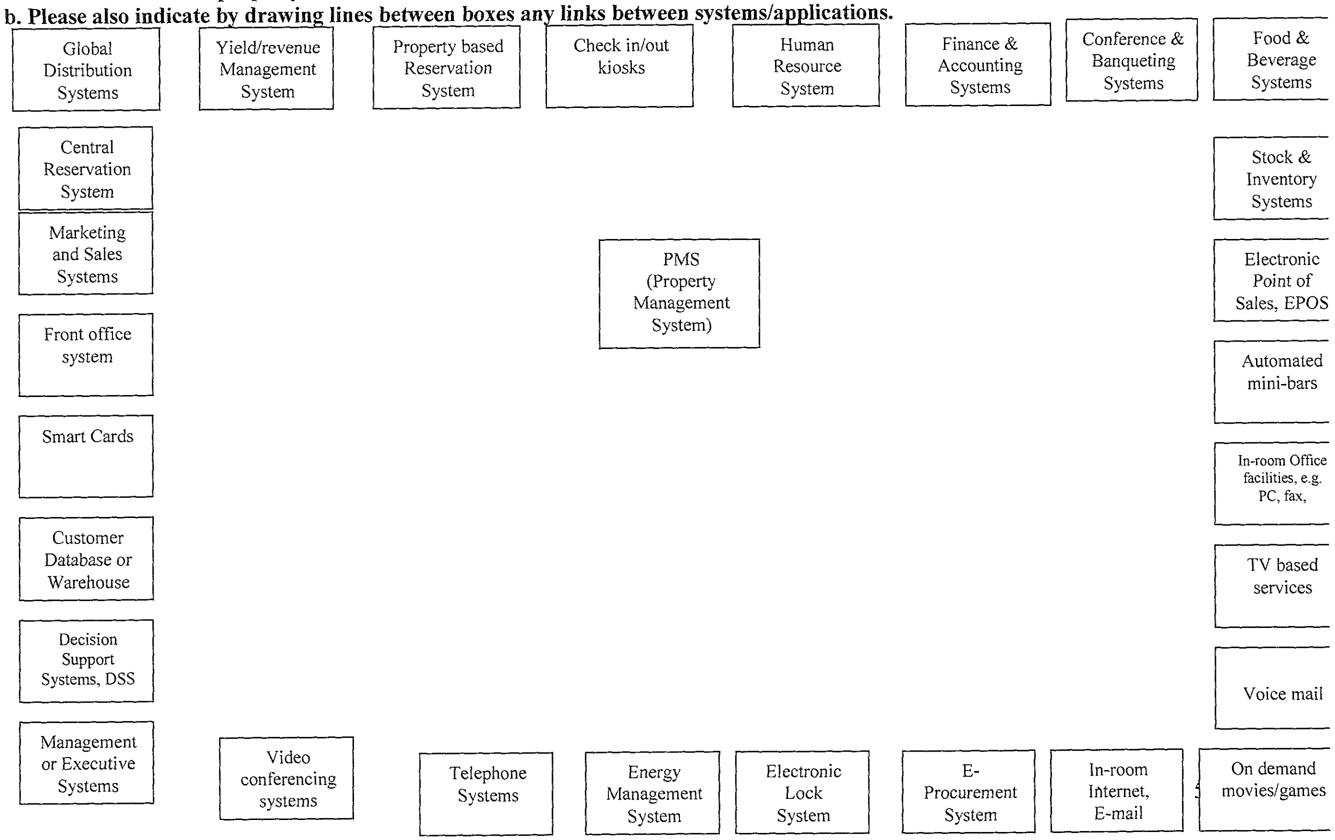
Enable staff of different departments to access/use customer information	
Automate tasks of front and/or back office staff	
Automate tasks of sales and marketing staff	
Plan personal customised promotions and/or sales offers	
Deliver Customer Relationship Management activities	
Plan the hotel strategy	
Other (please specify)	

PTO

5. Each box in the figure below represents an ICT system/application.

a. Please indicate by circling the appropriate box, which systems/applications you use in your hotel. Systems/applications can be either based at the property or accessible/available from your corporate offices.

b. Please also indicate by drawing lines between boxes any links between systems/applications.



Appendix D
Covering letter

Dear Sir / Madam,

The impact of Information Technology (IT) use on hotel performance

The CHIPR at the School of Management Studies for the Service Sector, University of Surrey, is conducting a major research study into the impact of Information Technology (IT) on hotel performance. This work is being carried out by Marianna Sigala and will be a major element of her doctoral studies. We hope you agree that a research study of the impact of different forms of IT on hotel profitability will be of great interest of the industry.

You have been selected to represent the industry in the study. We enclose a brief questionnaire, which we hope you will be prepared to complete and return to us. Your replies are a key element of this research. We realise that some of the information requested is of a confidential matter. We reassure you that any information received will be treated in the strictest confidence and will only be used for the purposes of this study. Any results published will not identify individual establishments. You will notice that the questionnaire is coded. This is only so that we can track responses.

Finally, we may need to investigate some of the issues in more depth with individual hotels. If you would be willing to take part in a personal interview please complete the slip attached to the questionnaire.

May we thank you in advance for your help and co-operation.

Yours sincerely,

Professor Peter Jones	Marianna Sigala
Forte Chair of Hotel Management	PhD Researcher
Centre for Hospitality Industry	
Productivity Research (CHIPR)	

Enclosed:
- Questionnaire
- Reply paid envelop

CHIPR information sheet

Appendix E
The impact of hotel demographic characteristics on productivity

E.1 The productivity impact of hotel location

ANOVA and chi-square tests

Descriptive

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM 3	rural	32	74.4745	21.25920	3.75813	66.8097	82.1392	37.91	100.00
	city centre	37	71.7308	19.45426	3.19826	65.2444	78.2172	35.16	100.00
	suburban	24	73.2231	14.91405	3.04432	66.9255	79.5208	53.14	100.00
	Total	93	73.0600	18.90517	1.96038	69.1665	76.9535	35.16	100.00
ROOM 4	rural	32	80.5526	20.66476	3.65305	73.1021	88.0030	40.73	100.00
	city centre	37	84.9981	15.24837	2.50682	79.9140	90.0822	50.06	100.00
	suburban	24	82.4988	16.44817	3.35747	75.5533	89.4442	55.21	100.00
	Total	93	82.8235	17.49952	1.81462	79.2195	86.4275	40.73	100.00
FB4	rural	32	72.7666	19.38060	3.42604	65.7791	79.7540	25.77	100.00
	city centre	37	71.9663	21.06195	3.46256	64.9439	78.9887	39.00	100.00
	suburban	24	78.5943	17.71100	3.61524	71.1156	86.0730	47.35	100.00
	Total	93	73.9521	19.65362	2.03799	69.9045	77.9997	25.77	100.00
TOT.O PER	rural	32	90.7851	12.85858	2.27310	86.1491	95.4211	52.72	100.00
	city centre	37	88.7053	15.31049	2.51703	83.6005	93.8101	42.77	100.00
	suburban	24	93.0091	8.74847	1.78577	89.3149	96.7032	73.02	100.00
	Total	93	90.5316	13.02069	1.35018	87.8500	93.2132	42.77	100.00
MARK. EFF	rural	32	44.2617	23.80081	4.20743	35.6806	52.8428	5.99	86.55
	city centre	37	47.2808	29.04277	4.77460	37.5975	56.9642	8.22	100.00
	suburban	24	44.8394	24.53137	5.00745	34.4807	55.1981	12.48	100.00
	Total	93	45.6119	25.94791	2.69067	40.2680	50.9559	5.99	100.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
ROOM3	2.903	2	90	.060
ROOM4	5.688	2	90	.005
FB4	1.363	2	90	.261
TOT.OPER	3.954	2	90	.023
MARK.EFF	.666	2	90	.516

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	130.031	2	65.015	.179	.837
	Within Groups	32751.282	90	363.903		
	Total	32881.312	92			
ROOM4	Between Groups	342.527	2	171.264	.554	.577
	Within Groups	27830.932	90	309.233		
	Total	28173.459	92			
FB4	Between Groups	708.091	2	354.045	.915	.404
	Within Groups	34828.285	90	386.981		
	Total	35536.376	92			
TOT.OPER	Between Groups	272.778	2	136.389	.801	.452
	Within Groups	15324.754	90	170.275		
	Total	15597.532	92			
MARK.EFF	Between Groups	175.720	2	87.860	.128	.880
	Within Groups	61767.335	90	686.304		
	Total	61943.054	92			

Ranks

	location	N	Mean Rank
ROOM4	rural	32	45.23
	city centre	37	48.76
	suburban	24	46.65
	Total	93	

Test Statistics

	ROOM4
Chi-Square	.310
df	2
Asymp. Sig.	.856

a Kruskal Wallis Test
b Grouping Variable: location

Ranks

	location	N	Mean Rank
TOT.OPER	Rural	32	48.06
	city centre	37	45.35
	Suburban	24	48.13
	Total	93	

Test Statistics

	TOT.OPER
Chi-Square	.263
df	2
Asymp. Sig.	.877

a Kruskal Wallis Test
b Grouping Variable: location

MARK.ONL * location Crosstabulation

			location			Total
			rural	city centre	suburban	
MARK.ONL	inefficient	Count	19	25	16	60
		Expected Count	20.6	23.9	15.5	60.0
		% within location	59.4%	67.6%	66.7%	64.5%
		Std. Residual	-.4	.2	.1	
	efficient	Count	13	12	8	33
		Expected Count	11.4	13.1	8.5	33.0
		% within location	40.6%	32.4%	33.3%	35.5%
		Std. Residual	.5	-.3	-.2	
Total		Count	32	37	24	93
		Expected Count	32.0	37.0	24.0	93.0
		% within location	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.568	2	.753
Likelihood Ratio	.564	2	.754
Linear-by-Linear Association	.365	1	.546
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.52.

E.2 The productivity impact of hotel design

ANOVA and Chi-Square tests

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM 3	old and/or traditional	31	67.0016	19.76261	3.54947	59.7527	74.2506	35.16	100.00
	redesigned/converted	25	68.1054	17.78129	3.55626	60.7657	75.4452	40.86	100.00
	purpose built	37	81.4836	15.98559	2.62802	76.1537	86.8134	51.23	100.00
	Total	93	73.0600	18.90517	1.96038	69.1665	76.9535	35.16	100.00
ROOM 4	old and/or traditional	31	75.7165	18.96051	3.40541	68.7617	82.6713	40.73	100.00
	redesigned/converted	25	78.8195	18.00165	3.60033	71.3887	86.2502	51.39	100.00
	purpose built	37	91.4834	11.63050	1.91204	87.6055	95.3612	65.62	100.00
	Total	93	82.8235	17.49952	1.81462	79.2195	86.4275	40.73	100.00
FB4	old and/or traditional	31	69.7582	20.59571	3.69910	62.2036	77.3127	25.77	100.00
	redesigned/converted	25	78.0955	19.39063	3.87813	70.0915	86.0996	46.02	100.00
	purpose built	37	74.6664	18.85148	3.09916	68.3810	80.9518	41.74	100.00
	Total	93	73.9521	19.65362	2.03799	69.9045	77.9997	25.77	100.00
TOT.O PER	old and/or traditional	31	85.2983	16.67118	2.99423	79.1833	91.4134	42.77	100.00
	redesigned/converted	25	89.9598	11.47386	2.29477	85.2236	94.6960	63.61	100.00
	purpose built	37	95.3025	8.16622	1.34252	92.5798	98.0253	68.05	100.00
	Total	93	90.5316	13.02069	1.35018	87.8500	93.2132	42.77	100.00
MARK. EFF	old and/or traditional	31	41.7599	24.78486	4.45149	32.6688	50.8511	8.22	100.00
	redesigned/converted	25	39.5423	26.19917	5.23983	28.7279	50.3568	9.70	100.00
	purpose built	37	52.9404	25.64325	4.21573	44.3905	61.4903	5.99	100.00
	Total	93	45.6119	25.94791	2.69067	40.2680	50.9559	5.99	100.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
ROOM3	.521	2	90	.596
ROOM4	9.735	2	90	.000
FB4	.259	2	90	.773
TOT.OPER	9.839	2	90	.000
MARK.EFF	.045	2	90	.956

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	4376.892	2	2188.446	6.910	.002
	Within Groups	28504.421	90	316.716		
	Total	32881.312	92			
ROOM4	Between Groups	4741.336	2	2370.668	9.105	.000
	Within Groups	23432.124	90	260.357		
	Total	28173.459	92			
FB4	Between Groups	993.342	2	496.671	1.294	.279
	Within Groups	34543.035	90	383.811		
	Total	35536.376	92			
TOT.OPER	Between Groups	1699.358	2	849.679	5.502	.006
	Within Groups	13898.174	90	154.424		
	Total	15597.532	92			
MARK.EFF	Between Groups	3368.102	2	1684.051	2.588	.081
	Within Groups	58574.952	90	650.833		
	Total	61943.054	92			

Multiple Comparisons - Scheffe

Dependent Variable	(I) Design	(J) Design	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
ROOM3	old and/or traditional	redesigned/converted	-1.1038	4.78386	.974	-13.0111	10.8035
		purpose built	-14.4819*	4.33319	.005	-25.2675	-3.6964
	redesigned/ converted	old and/or traditional	1.1038	4.78386	.974	-10.8035	13.0111
		purpose built	-13.3781*	4.60744	.018	-24.8463	-1.9099
	purpose built	old and/or traditional	14.4819*	4.33319	.005	3.6964	25.2675
		redesigned/converted	13.3781*	4.60744	.018	1.9099	24.8463
ROOM4	old and/or traditional	redesigned/converted	-3.1029	4.33738	.775	-13.8989	7.6930
		purpose built	-15.7668*	3.92878	.001	-25.5458	-5.9879
	redesigned/ converted	old and/or traditional	3.1029	4.33738	.775	-7.6930	13.8989
		purpose built	-12.6639*	4.17743	.013	-23.0618	-2.2660
	purpose built	old and/or traditional	15.7668*	3.92878	.001	5.9879	25.5458
		redesigned/converted	12.6639*	4.17743	.013	2.2660	23.0618
TOT.OPER	old and/or traditional	redesigned/converted	-4.6614	3.34042	.382	-12.9759	3.6530
		purpose built	-10.0042*	3.02573	.006	-17.5354	-2.4730
	redesigned/ converted	old and/or traditional	4.6614	3.34042	.382	-3.6530	12.9759
		purpose built	-5.3427	3.21723	.257	-13.3506	2.6651
	purpose built	old and/or traditional	10.0042*	3.02573	.006	2.4730	17.5354
		redesigned/converted	5.3427	3.21723	.257	-2.6651	13.3506

* The mean difference is significant at the .05 level.

Ranks

	Design	N	Mean Rank
TOT.OPER	old and/or traditional	31	38.94
	redesigned/converted	25	43.84
	purpose built	37	55.89
	Total	93	

Test Statistics

	TOT.OPER
Chi-Square	8.182
df	2
Asymp. Sig.	.017

a Kruskal Wallis Test
b Grouping Variable: Design

Ranks

	Design	N	Mean Rank
ROOM4	old and/or traditional	31	36.06
	redesigned/converted	25	40.50
	purpose built	37	60.55
	Total	93	

Test Statistics

	ROOM4
Chi-Square	16.543
df	2
Asymp. Sig.	.000

a Kruskal Wallis Test
b Grouping Variable: Design

MARK.ONL * Design Crosstabulation

			Design			Total
			old and/or traditional	redesigned/ converted	purpose built	
MARK.ONL	inefficient	Count	25	18	17	60
		Expected Count	20.0	16.1	23.9	60.0
		% within Design	80.6%	72.0%	45.9%	64.5%
		Std. Residual	1.1	.5	-1.4	
	efficient	Count	6	7	20	33
		Expected Count	11.0	8.9	13.1	33.0
		% within Design	19.4%	28.0%	54.1%	35.5%
		Std. Residual	-1.5	-.6	1.9	
Total		Count	31	25	37	93
		Expected Count	31.0	25.0	37.0	93.0
		% within Design	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.708	2	.008
Likelihood Ratio	9.813	2	.007
Linear-by-Linear Association	9.006	1	.003
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.87.

E.3 The productivity impact of hotel ownership

T-Tests and chi-square

Group Statistics

	ownership	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	independently owned	48	71.1536	18.85865	2.72201
	chained owned	45	75.0934	18.95288	2.82533
ROOM4	independently owned	48	78.4860	19.44266	2.80631
	chained owned	45	87.4501	13.93191	2.07685
FB4	independently owned	48	67.7553	18.57347	2.68085
	chained owned	45	80.5620	18.77699	2.79911
TOT.OPER	independently owned	48	86.9097	14.49287	2.09187
	chained owned	45	94.3949	10.02746	1.49481
MARK.EFF	independently owned	48	40.2662	21.85559	3.15458
	chained owned	45	51.3141	28.86405	4.30280

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM 3	Equal variances assumed	.008	.928	-1.004	91	.318	-3.9398	3.92260	-11.73155	3.85200
	Equal variances not assumed			-1.004	90.553	.318	-3.9398	3.92324	-11.73333	3.85378
ROOM 4	Equal variances assumed	13.272	.000	-2.541	91	.013	-8.9642	3.52802	-15.97213	-1.95618
	Equal variances not assumed			-2.568	85.262	.012	-8.9642	3.49122	-15.90534	-2.02297
FB4	Equal variances assumed	.159	.691	-3.305	91	.001	-12.8067	3.87444	-20.50279	-5.11059
	Equal variances not assumed			-3.304	90.475	.001	-12.8067	3.87582	-20.50612	-5.10725
TOT.O PER	Equal variances assumed	9.377	.003	-2.878	91	.005	-7.4852	2.60079	-12.65136	-2.31908
	Equal variances not assumed			-2.911	83.889	.005	-7.4852	2.57106	-12.59815	-2.37229
MARK .EFF	Equal variances assumed	3.784	.055	-2.089	91	.039	-11.0479	5.28832	-21.55250	-.54330
	Equal variances not assumed			-2.071	81.869	.042	-11.0479	5.33530	-21.66178	-.43403

Ranks

	ownership	N	Mean Rank	Sum of Ranks
ROOM4	independently owned	48	41.31	1983.00
	chained owned	45	53.07	2388.00
	Total	93		

Test Statistics

	ROOM4
Mann-Whitney U	807.000
Wilcoxon W	1983.000
Z	-2.143
Asymp. Sig. (2-tailed)	.032

a Grouping Variable: ownership

Ranks

	ownership	N	Mean Rank	Sum of Ranks
TOT.OPER	independently owned	48	39.52	1897.00
	chained owned	45	54.98	2474.00
	Total	93		

Test Statistics

	TOT.OPER
Mann-Whitney U	721.000
Wilcoxon W	1897.000
Z	-2.957
Asymp. Sig. (2-tailed)	.003

a Grouping Variable: ownership

MARK.ONL * ownership Crosstabulation

			ownership		Total
			independently owned	chained owned	
MARK.ONL	inefficient	Count	32	28	60
		Expected Count	31.0	29.0	60.0
		% within ownership	66.7%	62.2%	64.5%
		Std. Residual	.2	-.2	
	efficient	Count	16	17	33
		Expected Count	17.0	16.0	33.0
		% within ownership	33.3%	37.8%	35.5%
		Std. Residual	-.3	.3	
Total		Count	48	45	93
		Expected Count	48.0	45.0	93.0
		% within ownership	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.200	1	.654		
Continuity Correction	.053	1	.817		
Likelihood Ratio	.200	1	.654		
Fisher's Exact Test				.671	.409
Linear-by-Linear Association	.198	1	.656		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.97.

E.4 The productivity impact of hotel management arrangement

ANOVA and chi-square

1= independent management

2=chain management

3=independent management and consortia membership

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM 3	1.00	28	69.2494	18.29217	3.45690	62.1565	76.3424	35.16	100.00
	2.00	47	74.4522	19.21525	2.80283	68.8104	80.0940	39.49	100.00
	3.00	18	75.3523	19.20536	4.52675	65.8017	84.9029	37.91	100.00
	Total	93	73.0600	18.90517	1.96038	69.1665	76.9535	35.16	100.00
ROOM 4	1.00	28	75.8133	18.91272	3.57417	68.4797	83.1469	50.06	100.00
	2.00	47	86.3336	15.24960	2.22438	81.8562	90.8111	40.73	100.00
	3.00	18	84.5628	18.48520	4.35700	75.3703	93.7553	44.97	100.00
	Total	93	82.8235	17.49952	1.81462	79.2195	86.4275	40.73	100.00
FB4	1.00	28	67.9329	16.06570	3.03613	61.7033	74.1625	39.00	100.00
	2.00	47	79.2400	19.44331	2.83610	73.5313	84.9488	43.10	100.00
	3.00	18	69.5080	22.35192	5.26840	58.3926	80.6233	25.77	100.00
	Total	93	73.9521	19.65362	2.03799	69.9045	77.9997	25.77	100.00
TOT.O PER	1.00	28	87.4942	14.26019	2.69492	81.9647	93.0237	42.77	100.00
	2.00	47	93.2074	11.69758	1.70627	89.7729	96.6419	52.72	100.00
	3.00	18	88.2695	13.55971	3.19605	81.5264	95.0125	62.09	100.00
	Total	93	90.5316	13.02069	1.35018	87.8500	93.2132	42.77	100.00
MARK. EFF	1.00	28	41.6551	23.58461	4.45707	32.5100	50.8003	9.41	86.55
	2.00	47	49.7986	29.17568	4.25571	41.2323	58.3649	5.99	100.00
	3.00	18	40.8353	18.93599	4.46326	31.4186	50.2519	12.48	73.83
	Total	93	45.6119	25.94791	2.69067	40.2680	50.9559	5.99	100.00

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
ROOM3	.189	2	90	.828
ROOM4	2.287	2	90	.107
FB4	2.065	2	90	.133
TOT.OPER	1.642	2	90	.199
MARK.EFF	2.768	2	90	.068

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	592.246	2	296.123	.825	.441
	Within Groups	32289.066	90	358.767		
	Total	32881.312	92			
ROOM4	Between Groups	2009.542	2	1004.771	3.456	.036
	Within Groups	26163.917	90	290.710		
	Total	28173.459	92			
FB4	Between Groups	2684.203	2	1342.102	3.677	.029
	Within Groups	32852.173	90	365.024		
	Total	35536.376	92			
TOT.OPER	Between Groups	686.951	2	343.475	2.073	.132
	Within Groups	14910.581	90	165.673		
	Total	15597.532	92			
MAR K.EF F	Between Groups	1672.882	2	836.441	1.249	.292
	Within Groups	60270.173	90	669.669		
	Total	61943.054	92			

Multiple Comparisons-Scheffe

Dependent Variable	(I) MANAG	(J) MANAG	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
ROOM4	1.00	2.00	-10.5203*	4.07036	.040	-20.6517	-.3890
		3.00	-8.7495	5.15103	.242	-21.5707	4.0717
	2.00	1.00	10.5203*	4.07036	.040	.3890	20.6517
		3.00	1.7708	4.72609	.932	-9.9926	13.5343
	3.00	1.00	8.7495	5.15103	.242	-4.0717	21.5707
		2.00	-1.7708	4.72609	.932	-13.5343	9.9926
FB4	1.00	2.00	-11.3072*	4.56104	.051	-22.6598	.0455
		3.00	-1.5751	5.77198	.963	-15.9418	12.7917
	2.00	1.00	11.3072*	4.56104	.051	-.0455	22.6598
		3.00	9.7321	5.29581	.191	-3.4495	22.9136
	3.00	1.00	1.5751	5.77198	.963	-12.7917	15.9418
		2.00	-9.7321	5.29581	.191	-22.9136	3.4495

* The mean difference is significant at the .05 level.

MARK.ONL * MANAG Crosstabulation

			Management arrangement			Total
			1.00	2.00	3.00	
MARK.ONL	inefficient	Count	20	30	10	60
		Expected Count	18.1	30.3	11.6	60.0
		% within MANAG	71.4%	63.8%	55.6%	64.5%
		Std. Residual	.5	-.1	-.5	
	efficient	Count	8	17	8	33
		Expected Count	9.9	16.7	6.4	33.0
		% within MANAG	28.6%	36.2%	44.4%	35.5%
		Std. Residual	-.6	.1	.6	
Total		Count	28	47	18	93
		Expected Count	28.0	47.0	18.0	93.0
		% within MANAG	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.225	2	.542
Likelihood Ratio	1.226	2	.542
Linear-by-Linear Association	1.211	1	.271
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.39.

E.5 The impact of market segments and distribution channels on market efficiency in rooms division

T-tests

Group Statistics

	MARK.ONL	N	Mean	Std. Deviation	Std. Error Mean
repeat customers	inefficient	60	36.2833	17.44443	2.25207
	efficient	33	38.1515	21.75879	3.78772
BUSINESS	inefficient	60	46.357	21.0063	2.7119
	efficient	33	48.603	22.2156	3.8672
LEISURE	inefficient	60	38.2500	23.34805	3.01422
	efficient	33	34.2818	24.78730	4.31492
CONFEREN	inefficient	60	11.8433	10.53059	1.35949
	efficient	33	11.8091	10.50703	1.82904
PROPERTY	inefficient	60	70.2917	12.34404	1.59361
	efficient	33	67.9697	12.08430	2.10361
THRID.P	inefficient	60	25.8883	12.89905	1.66526
	efficient	33	28.0576	10.49926	1.82769
INTERNET	inefficient	60	3.1033	3.89850	.50329
	efficient	33	3.9727	4.75061	.82698

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
repe at cust	Equal variances assumed	4.249	.042	-.452	91	.652	-1.8682	4.13363	-10.07912	6.34276
	Equal variances not assumed			-.424	54.903	.673	-1.8682	4.40666	-10.69967	6.96331
BUS INE SS	Equal variances assumed	.022	.883	-.483	91	.630	-2.246	4.6464	-11.4759	6.9832
	Equal variances not assumed			-.476	62.954	.636	-2.246	4.7233	-11.6853	7.1926
LEI SUR E	Equal variances assumed	.010	.920	.767	91	.445	3.9682	5.17194	-6.30523	14.24160
	Equal variances not assumed			.754	62.747	.454	3.9682	5.26346	-6.55083	14.48720
CO NFE REN	Equal variances assumed	.297	.587	.015	91	.988	.0342	2.28045	-4.49559	4.56407
	Equal variances not assumed			.015	66.171	.988	.0342	2.27895	-4.51561	4.58409
PRO PER TY	Equal variances assumed	.012	.914	.874	91	.384	2.3220	2.65560	-2.95306	7.59700
	Equal variances not assumed			.880	67.255	.382	2.3220	2.63908	-2.94529	7.58923
THR ID.P	Equal variances assumed	2.060	.155	-.827	91	.411	-2.1692	2.62443	-7.38235	3.04387
	Equal variances not assumed			-.877	78.021	.383	-2.1692	2.47255	-7.09170	2.75322
INT ERN ET	Equal variances assumed	1.947	.166	-.951	91	.344	-.8694	.91411	-2.68515	.94636
	Equal variances not assumed			-.898	55.933	.373	-.8694	.96809	-2.80876	1.06997

Ranks

	MARK.ONL	N	Mean Rank	Sum of Ranks
repeat customers	inefficient	60	46.86	2811.50
	efficient	33	47.26	1559.50
	Total	93		

Test Statistics

	repeat customers
Mann-Whitney U	981.500
Wilcoxon W	2811.500
Z	-.068
Asymp. Sig. (2-tailed)	.945

a Grouping Variable: MARK.ONL

E.6 The productivity impact of revenue orientation

T-tests and chi-square

Group Statistics

	revenue orientation	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	rooms	32	78.2259	16.21862	2.86707
	fb	61	70.3500	19.75896	2.52988
ROOM4	rooms	32	88.3525	13.50789	2.38788
	fb	61	79.9230	18.71972	2.39681
FB4	rooms	32	66.1922	17.49319	3.09239
	fb	61	78.0229	19.62663	2.51293
TOT.OPER	rooms	32	88.6474	11.82031	2.08955
	fb	61	91.5200	13.59720	1.74094
MARK.EFF	rooms	32	43.9146	25.56073	4.51854
	fb	61	46.5023	26.31496	3.36929

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM 3	Equal variances assumed	3.273	.074	1.937	91	.056	7.8759	4.06614	-.20098	15.95280
	Equal variances not assumed			2.060	74.677	.043	7.8759	3.82366	.25825	15.49358
ROOM 4	Equal variances assumed	11.439	.001	2.255	91	.027	8.4295	3.73758	1.00531	15.85379
	Equal variances not assumed			2.492	81.952	.015	8.4295	3.38330	1.69904	15.16006
FB4	Equal variances assumed	1.196	.277	-2.864	91	.005	-11.8307	4.13124	-20.03686	-3.62445
	Equal variances not assumed			-2.969	69.746	.004	-11.8307	3.98468	-19.77836	-3.88294
TOT.O PER	Equal variances assumed	.640	.426	-1.011	91	.315	-2.8726	2.84174	-8.51736	2.77217
	Equal variances not assumed			-1.056	71.240	.294	-2.8726	2.71976	-8.29533	2.55015
MARK EFF	Equal variances assumed	.081	.777	-.455	91	.650	-2.5877	5.68832	-13.88685	8.71144
	Equal variances not assumed			-.459	64.719	.648	-2.5877	5.63643	-13.84535	8.66994

Ranks

	revenue orientation	N	Mean Rank	Sum of Ranks
ROOM4	rooms	32	54.08	1730.50
	fb	61	43.29	2640.50
	Total	93		

Test Statistics

	ROOM4
Mann-Whitney U	749.500
Wilcoxon W	2640.500
Z	-1.870
Asymp. Sig. (2-tailed)	.061

a Grouping Variable: revenue orientation

MARK.ONL * revenue orientation Crosstabulation

			revenue orientation		Total
			rooms	fb	
MARK.ONL	inefficie	Count	20	40	60
		Expected Count	20.6	39.4	60.0
		% within revenue orientation	62.5%	65.6%	64.5%
		Std. Residual	-.1	.1	
	efficient	Count	12	21	33
		Expected Count	11.4	21.6	33.0
		% within revenue orientation	37.5%	34.4%	35.5%
		Std. Residual	.2	-.1	
Total		Count	32	61	93
		Expected Count	32.0	61.0	93.0
		% within revenue orientation	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.087	1	.769		
Continuity Correction	.004	1	.947		
Likelihood Ratio	.086	1	.769		
Fisher's Exact Test				1.000	.701
Linear-by-Linear Association	.086	1	.770		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.35.

Appendix F
Productivity impact of ICT

Appendix F.1
The productivity impact of single ICT availability

F.1.1 T-Tests for investigating the impact of ICTs availability on efficiency in rooms and FB divisions and overall property

Descriptive

	PMS	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	78	75.43343	17.56566	1.98892
	no	15	60.71805	21.37843	5.519888
ROOM4	yes	78	82.78262	17.3447	1.9639
	no	15	83.03586	18.9135	4.883445
FB4	yes	78	74.96571	18.65493	2.112255
	no	15	68.6814	24.26496	6.265185
TOT.OPER	yes	78	92.27155	11.31897	1.281621
	no	15	81.48367	17.46065	4.508321
MARK.EFF	yes	78	46.33944	25.49508	2.886749
	no	15	41.82893	28.83101	7.444135

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROO M3	Equal variances assumed	0.377	0.541	2.867	91.000	0.005	14.715	5.132	4.520	24.910
	Equal variances not assumed			2.508	17.817	0.022	14.715	5.867	2.380	27.051
ROO M4	Equal variances assumed	0.009	0.923	-0.051	91.000	0.959	-0.253	4.961	-10.107	9.601
	Equal variances not assumed			-0.048	18.805	0.962	-0.253	5.264	-11.278	10.771
FB4	Equal variances assumed	2.669	0.106	1.136	91.000	0.259	6.284	5.532	-4.705	17.274
	Equal variances not assumed			0.950	17.323	0.355	6.284	6.612	-7.645	20.214
TOT. OPE R	Equal variances assumed	4.097	0.056	3.070	91.000	0.003	10.788	3.514	3.809	17.767
	Equal variances not assumed			2.302	16.335	0.035	10.788	4.687	0.869	20.707
MAR K.EF F	Equal variances assumed	0.465	0.497	0.614	91.000	0.540	4.511	7.340	-10.070	19.091
	Equal variances not assumed			0.565	18.451	0.579	4.511	7.984	-12.234	21.255

Descriptive

	Intranet	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	30	74.06809	20.01507	3.654235
	no	63	72.57993	18.4997	2.330743
ROOM4	yes	30	87.71383	17.35599	3.168755
	no	63	80.49472	17.21714	2.169156
FB4	yes	30	71.95767	19.80372	3.615647
	no	63	74.90185	19.66936	2.478106
TOT.OPER	yes	30	91.01787	12.0694	2.203562
	no	63	90.3	13.53765	1.705584
MARK.EFF	yes	30	47.59477	23.60674	4.309982
	no	63	44.66774	27.12215	3.417069

T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROO M3	Equal variances assumed	0.335	0.564	0.353	91.000	0.725	1.488	4.214	-6.882	9.858
	Equal variances not assumed			0.343	53.271	0.733	1.488	4.334	-7.204	10.181
ROO M4	Equal variances assumed	0.193	0.661	1.885	91.000	0.063	7.219	3.829	-0.387	14.825
	Equal variances not assumed			1.880	56.721	0.065	7.219	3.840	-0.471	14.910
FB4	Equal variances assumed	0.016	0.901	-0.673	91.000	0.502	-2.944	4.373	-11.630	5.742
	Equal variances not assumed			-0.672	56.784	0.505	-2.944	4.383	-11.722	5.834
TOT. OPE R	Equal variances assumed	0.234	0.629	0.247	91.000	0.805	0.718	2.903	-5.049	6.485
	Equal variances not assumed			0.258	63.496	0.798	0.718	2.787	-4.850	6.285
MAR K.EF F	Equal variances assumed	1.251	0.266	0.506	91.000	0.614	2.927	5.779	-8.553	14.407
	Equal variances not assumed			0.532	64.918	0.596	2.927	5.500	-8.058	13.912

Descriptive

	Database	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	67	75.74276	18.15118	2.217519
	no	26	66.14667	19.40284	3.805209
ROOM4	yes	67	84.78182	17.09676	2.088702
	no	26	77.77695	17.84668	3.500022
FB4	yes	67	74.39773	19.17853	2.34303
	no	26	72.80378	21.17823	4.153393
TOT.OPER	yes	67	91.50712	12.79429	1.563071
	no	26	88.01767	13.51394	2.650301
MARK.EFF	yes	67	47.35383	25.57805	3.124856
	no	26	41.12324	26.85986	5.267651

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.199	0.656	2.245	91.000	0.027	9.596	4.275	1.104	18.089
	Equal variances not assumed			2.179	42.986	0.035	9.596	4.404	0.714	18.478
ROOM4	Equal variances assumed	0.135	0.715	1.752	91.000	0.083	7.005	3.999	-0.938	14.948
	Equal variances not assumed			1.719	43.870	0.093	7.005	4.076	-1.210	15.220
FB4	Equal variances assumed	0.321	0.573	0.349	91.000	0.728	1.594	4.563	-7.470	10.658
	Equal variances not assumed			0.334	41.839	0.740	1.594	4.769	-8.031	11.219
TOT.OPER	Equal variances assumed	0.402	0.527	1.162	91.000	0.248	3.489	3.003	-2.475	9.454
	Equal variances not assumed			1.134	43.426	0.263	3.489	3.077	-2.714	9.693
MARK.EFF	Equal variances assumed	0.051	0.822	1.040	91.000	0.301	6.231	5.993	-5.673	18.135
	Equal variances not assumed			1.017	43.644	0.315	6.231	6.125	-6.116	18.577

Descriptive

	YM	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	48	75.58867	18.50614	2.671132
	no	45	70.36271	19.15876	2.85602
ROOM4	yes	48	84.53268	17.99597	2.597495
	no	45	81.0003	16.96418	2.52887
FB4	yes	48	77.20998	20.30959	2.931436
	no	45	70.47705	18.52331	2.761292
TOT.OPER	yes	48	93.12039	12.04795	1.738972
	no	45	87.77016	13.5768	2.02391
MARK.EFF	yes	48	49.31443	25.61364	3.697011
	no	45	41.66262	26.00193	3.876139

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.000	0.984	1.338	91.000	0.184	5.226	3.906	-2.533	12.985
	Equal variances not assumed			1.336	90.102	0.185	5.226	3.910	-2.543	12.995
ROOM4	Equal variances assumed	0.267	0.607	0.973	91.000	0.333	3.532	3.632	-3.683	10.747
	Equal variances not assumed			0.974	90.996	0.332	3.532	3.625	-3.669	10.733
FB4	Equal variances assumed	1.597	0.209	1.667	91.000	0.099	6.733	4.039	-1.291	14.756
	Equal variances not assumed			1.672	90.935	0.098	6.733	4.027	-1.267	14.732
TOT.OPER	Equal variances assumed	0.529	0.469	2.013	91.000	0.047	5.350	2.658	0.070	10.630
	Equal variances not assumed			2.005	88.031	0.048	5.350	2.668	0.047	10.653
MARK.EFF	Equal variances assumed	0.000	0.988	1.429	91.000	0.156	7.652	5.354	-2.983	18.287
	Equal variances not assumed			1.429	90.417	0.157	7.652	5.357	-2.989	18.293

Descriptive

	GDS	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	47	74.6463	19.40538	2.830566
	no	46	71.43917	18.45116	2.720475
ROOM4	yes	47	83.81752	18.81074	2.743829
	no	46	81.80781	16.19516	2.387846
FB4	yes	47	74.71619	18.90191	2.757126
	no	46	73.17142	20.57287	3.033304
TOT.OPER	yes	47	90.16367	13.53957	1.97495
	no	46	90.90747	12.60683	1.858776
MARK.EFF	yes	47	51.02175	26.07172	3.802951
	no	46	40.08453	24.89728	3.670904

t-tests

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.910	0.343	0.816	91.000	0.416	3.207	3.928	-4.596	11.010
	Equal variances not assumed			0.817	90.925	0.416	3.207	3.926	-4.591	11.006
ROOM4	Equal variances assumed	1.998	0.161	0.552	91.000	0.583	2.010	3.643	-5.227	9.247
	Equal variances not assumed			0.553	89.553	0.582	2.010	3.637	-5.217	9.236
FB4	Equal variances assumed	0.524	0.471	0.377	91.000	0.707	1.545	4.095	-6.590	9.680
	Equal variances not assumed			0.377	89.986	0.707	1.545	4.099	-6.599	9.688
TOT.OPER	Equal variances assumed	0.833	0.364	-0.274	91.000	0.785	-0.744	2.714	-6.135	4.648
	Equal variances not assumed			-0.274	90.777	0.785	-0.744	2.712	-6.131	4.644
MARK.EFF	Equal variances assumed	0.152	0.698	2.068	91.000	0.041	10.937	5.288	0.433	21.442
	Equal variances not assumed			2.069	90.946	0.041	10.937	5.286	0.438	21.437

Descriptive

	CRS	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	63	74.65658	18.73235	2.360054
	no	30	69.70712	19.1434	3.49509
ROOM4	yes	63	84.69552	17.30375	2.180067
	no	30	78.89216	17.54305	3.202908
FB4	yes	63	72.59167	18.97142	2.390174
	no	30	76.80904	21.05837	3.844715
TOT.OPER	yes	63	91.29897	12.87013	1.621485
	no	30	88.92004	13.40718	2.447804
MARK.EFF	yes	63	48.9305	25.83747	3.255215
	no	30	38.64296	25.19073	4.599177

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.032	0.859	1.183	91.000	0.240	4.949	4.185	-3.363	13.262
	Equal variances not assumed			1.174	56.027	0.246	4.949	4.217	-3.499	13.398
ROOM4	Equal variances assumed	0.016	0.900	1.505	91.000	0.136	5.803	3.855	-1.855	13.462
	Equal variances not assumed			1.498	56.430	0.140	5.803	3.874	-1.957	13.563
FB4	Equal variances assumed	0.666	0.416	-0.967	91.000	0.336	-4.217	4.361	-12.880	4.446
	Equal variances not assumed			-0.932	52.107	0.356	-4.217	4.527	-13.301	4.867
TOT.OPER	Equal variances assumed	0.062	0.805	0.822	91.000	0.413	2.379	2.893	-3.368	8.126
	Equal variances not assumed			0.810	55.074	0.421	2.379	2.936	-3.505	8.263
MARK.EFF	Equal variances assumed	0.016	0.900	1.809	91.000	0.074	10.288	5.686	-1.007	21.582
	Equal variances not assumed			1.826	58.470	0.073	10.288	5.635	-0.989	21.565

Descriptive

	PBRS	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	70	76.90309	18.16754	2.171436
	no	23	61.36355	16.41339	3.422428
ROOM4	yes	70	84.10288	16.94911	2.025806
	no	23	78.92959	18.93571	3.948369
FB4	yes	70	74.3957	19.2297	2.298389
	no	23	72.60205	21.28355	4.437926
TOT.OPER	yes	70	91.51779	12.32112	1.472656
	no	23	87.53003	14.84365	3.095114
MARK.EFF	yes	70	47.76815	25.99489	3.106983
	no	23	39.04958	25.22758	5.260313

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROO M3	Equal variances assumed	2.111	0.150	3.641	91.000	0.000	15.540	4.268	7.061	24.018
	Equal variances not assumed			3.834	41.151	0.000	15.540	4.053	7.355	23.724
ROO M4	Equal variances assumed	1.380	0.243	1.234	91.000	0.221	5.173	4.194	-3.158	13.504
	Equal variances not assumed			1.166	34.348	0.252	5.173	4.438	-3.842	14.188
FB4	Equal variances assumed	0.004	0.948	0.378	91.000	0.706	1.794	4.746	-7.633	11.220
	Equal variances not assumed			0.359	34.591	0.722	1.794	4.998	-8.357	11.944
TOT. OPE R	Equal variances assumed	0.664	0.417	1.279	91.000	0.204	3.988	3.119	-2.207	10.183
	Equal variances not assumed			1.163	32.556	0.253	3.988	3.428	-2.989	10.965
MAR K.EF F	Equal variances assumed	0.882	0.350	1.405	91.000	0.163	8.719	6.204	-3.604	21.041
	Equal variances not assumed			1.427	38.532	0.162	8.719	6.109	-3.644	21.081

Descriptive

	Marketing & Sales System	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	40	75.89028	19.89717	3.146019
	no	53	70.9239	18.01658	2.474768
ROOM4	yes	40	82.82748	18.20238	2.878049
	no	53	82.82044	17.12607	2.352447
FB4	yes	40	77.16304	17.10584	2.704671
	no	53	71.52877	21.21363	2.913916
TOT.OPER	yes	40	93.55796	10.98344	1.736635
	no	53	88.24751	14.03969	1.928499
MARK.EFF	yes	40	47.14684	27.06012	4.278581
	no	53	44.45353	25.27538	3.471841

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROO M3	Equal variances assumed	1.203	0.276	1.258	91.000	0.212	4.966	3.947	-2.874	12.807
	Equal variances not assumed			1.241	79.398	0.218	4.966	4.003	-3.000	12.933
ROO M4	Equal variances assumed	0.229	0.634	0.002	91.000	0.998	0.007	3.685	-7.313	7.327
	Equal variances not assumed			0.002	81.302	0.998	0.007	3.717	-7.388	7.403
FB4	Equal variances assumed	4.823	0.031	1.375	91.000	0.172	5.634	4.097	-2.503	13.772
	Equal variances not assumed			1.417	90.566	0.160	5.634	3.976	-2.263	13.532
TOT. OPE R	Equal variances assumed	2.607	0.110	1.978	91.000	0.051	5.310	2.685	-0.023	10.644
	Equal variances not assumed			2.046	90.863	0.044	5.310	2.595	0.155	10.466
MAR K.EF F	Equal variances assumed	0.103	0.749	0.494	91.000	0.623	2.693	5.457	-8.147	13.533
	Equal variances not assumed			0.489	80.946	0.626	2.693	5.510	-8.270	13.657

Mann-Whitney U

Ranks				
	Marketing & sales system	N	Mean Rank	Sum of Ranks
FB4	No	53	44.0566	2335
	Yes	40	50.9	2036
	Total	93		

Test Statistics	
	FB4
Mann-Whitney U	904
Wilcoxon W	2335
Z	-1.21495
Asymp. Sig. (2-tailed)	0.224385

Descriptive

	Front office system	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	86	74.43144	18.51382	1.996397
	no	7	56.21066	16.31728	6.167353
ROOM4	yes	86	83.50847	17.0224	1.835573
	no	7	74.40776	22.38878	8.462163
FB4	yes	86	73.74603	19.04545	2.053724
	no	7	76.48393	27.85641	10.52873
TOT.OPER	yes	86	90.88643	12.94254	1.39563
	no	7	86.17183	14.23234	5.379319
MARK.EFF	yes	86	45.41232	25.97556	2.801017
	no	7	48.0644	27.52424	10.40318

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	1.287	0.260	2.523	91.000	0.013	18.221	7.223	3.873	32.568
	Equal variances not assumed			2.811	7.318	0.025	18.221	6.482	3.026	33.415
ROOM4	Equal variances assumed	1.069	0.304	1.329	91.000	0.187	9.101	6.850	-4.505	22.707
	Equal variances not assumed			1.051	6.577	0.330	9.101	8.659	-11.645	29.846
FB4	Equal variances assumed	1.619	0.207	-0.353	91.000	0.725	-2.738	7.762	-18.156	12.680
	Equal variances not assumed			-0.255	6.465	0.806	-2.738	10.727	-28.536	23.060
TOT.OPER	Equal variances assumed	0.076	0.784	0.920	91.000	0.360	4.715	5.122	-5.460	14.889
	Equal variances not assumed			0.848	6.833	0.425	4.715	5.557	-8.492	17.921
MARK.EFF	Equal variances assumed	0.038	0.846	-0.259	91.000	0.796	-2.652	10.251	-23.014	17.710
	Equal variances not assumed			-0.246	6.899	0.813	-2.652	10.774	-28.204	22.899

Descriptive

	Telephone system	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	75	74.75095	18.42882	2.127977
	no	18	66.01426	19.76526	4.658717
ROOM4	yes	75	84.29383	17.0652	1.970519
	no	18	76.69693	18.44761	4.348143
FB4	yes	75	73.86126	19.58841	2.261875
	no	18	74.33067	20.49239	4.830102
TOT.OPER	yes	75	91.52273	12.68902	1.465202
	no	18	86.40177	13.9369	3.284959
MARK.EFF	yes	75	47.59909	25.73114	2.971176
	no	18	37.33215	25.91631	6.108532

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.003	0.958	1.781	91.000	0.078	8.737	4.904	-1.005	18.479
	Equal variances not assumed			1.706	24.588	0.101	8.737	5.122	-1.821	19.294
ROOM4	Equal variances assumed	0.197	0.658	1.670	91.000	0.098	7.597	4.549	-1.439	16.633
	Equal variances not assumed			1.591	24.463	0.124	7.597	4.774	-2.246	17.440
FB4	Equal variances assumed	0.212	0.646	-0.091	91.000	0.928	-0.469	5.186	-10.772	9.833
	Equal variances not assumed			-0.088	24.997	0.931	-0.469	5.333	-11.454	10.515
TOT.OPER	Equal variances assumed	0.154	0.696	1.509	91.000	0.135	5.121	3.394	-1.621	11.863
	Equal variances not assumed			1.424	24.217	0.167	5.121	3.597	-2.299	12.541
MARK.EFF	Equal variances assumed	0.004	0.947	1.518	91.000	0.132	10.267	6.763	-3.166	23.700
	Equal variances not assumed			1.511	25.665	0.143	10.267	6.793	-3.705	24.239

Descriptive

	Check in/out kiosks	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	11	80.96907	24.55918	7.404871
	no	82	71.999	17.94002	1.981144
ROOM4	yes	11	82.37949	24.66646	7.437217
	no	82	82.88302	16.51287	1.823541
FB4	yes	11	64.05073	16.4725	4.966645
	no	82	75.28035	19.7515	2.181188
TOT.OPER	yes	11	85.58277	18.04607	5.441094
	no	82	91.19544	12.18955	1.34611
MARK.EFF	yes	11	49.36418	31.19397	9.405335
	no	82	45.10859	25.34619	2.799018

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	4.363	0.040	1.487	91.000	0.140	8.970	6.031	-3.009	20.950
	Equal variances not assumed			1.170	11.476	0.266	8.970	7.665	-7.816	25.756
ROOM4	Equal variances assumed	9.012	0.003	-0.089	91.000	0.929	-0.504	5.650	-11.726	10.719
	Equal variances not assumed			-0.066	11.234	0.949	-0.504	7.658	-17.315	16.308
FB4	Equal variances assumed	2.532	0.115	-1.801	91.000	0.075	-11.230	6.235	-23.615	1.156
	Equal variances not assumed			-2.070	14.164	0.057	-11.230	5.424	-22.851	0.392
TOT.OPER	Equal variances assumed	6.608	0.012	-1.348	91.000	0.181	-5.613	4.162	-13.881	2.656
	Equal variances not assumed			-1.001	11.256	0.338	-5.613	5.605	-17.915	6.690
MARK.EFF	Equal variances assumed	1.306	0.256	0.509	91.000	0.612	4.256	8.366	-12.362	20.873
	Equal variances not assumed			0.434	11.838	0.672	4.256	9.813	-17.158	25.669

Non-parametric tests

Ranks

	Check in/out kiosks	N	Mean Rank	Sum of Ranks
ROOM3	No	82	45.59146	3738.5
	Yes	11	57.5	632.5
	Total	93		
ROOM4	No	82	46.60976	3822
	Yes	11	49.90909	549
	Total	93		
TOT.OPER	No	82	47.58537	3902
	Yes	11	42.63636	469
	Total	93		

Test Statistics

	ROOM3	ROOM4	TOT.OPER
Mann-Whitney U	335.5	419	403
Wilcoxon W	3738.5	3822	469
Z	-1.37756	-0.38868	-0.61188
Asymp. Sig. (2-tailed)	0.16834	0.69751	0.54062

Descriptive

	HRM	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	17	79.69008	21.26175	5.156733
	no	76	71.57693	18.15998	2.083093
ROOM4	yes	17	83.07602	19.96038	4.841103
	no	76	82.76697	17.04796	1.955535
FB4	yes	17	79.69643	17.72608	4.299206
	no	76	72.6672	19.94075	2.287361
TOT.OPER	yes	17	93.81066	11.4008	2.7651
	no	76	89.79809	13.31375	1.527192
MARK.EFF	yes	17	51.02881	22.68783	5.502608
	0	76	44.40027	26.60748	3.052087

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	2.595	0.111	1.613	91.000	0.110	8.113	5.029	-1.875	18.102
	Equal variances not assumed			1.459	21.526	0.159	8.113	5.562	-3.436	19.662
ROOM4	Equal variances assumed	1.330	0.252	0.065	91.000	0.948	0.309	4.721	-9.068	9.686
	Equal variances not assumed			0.059	21.525	0.953	0.309	5.221	-10.533	11.151
FB4	Equal variances assumed	0.512	0.476	1.339	91.000	0.184	7.029	5.250	-3.400	17.458
	Equal variances not assumed			1.443	25.898	0.161	7.029	4.870	-2.983	17.041
TOT.OPER	Equal variances assumed	0.801	0.373	1.151	91.000	0.253	4.013	3.487	-2.914	10.940
	Equal variances not assumed			1.270	26.720	0.215	4.013	3.159	-2.472	10.497
MARK.EFF	Equal variances assumed	0.248	0.620	0.952	91.000	0.344	6.629	6.965	-7.207	20.464
	Equal variances not assumed			1.053	26.818	0.302	6.629	6.292	-6.286	19.544

Descriptive

	F&A systems	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	73	75.11628	18.59341	2.176194
	no	20	65.55449	18.57351	4.153163
ROOM4	yes	73	84.28051	17.12623	2.004473
	no	20	77.50525	18.25933	4.082911
FB4	yes	73	75.54256	18.56939	2.173383
	no	20	68.14697	22.76946	5.091406
TOT.OPER	yes	73	91.68031	11.96446	1.400334
	no	20	85.33867	15.96529	3.569947
MARK.EFF	yes	73	45.67892	25.81551	3.021477
	no	20	45.36747	27.10391	6.060618

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.119	0.730	2.038	91.000	0.044	9.562	4.692	0.242	18.881
	Equal variances not assumed			2.039	30.264	0.050	9.562	4.689	-0.010	19.134
ROOM4	Equal variances assumed	0.136	0.714	1.546	91.000	0.126	6.775	4.384	-1.932	15.483
	Equal variances not assumed			1.490	28.821	0.147	6.775	4.548	-2.530	16.080
FB4	Equal variances assumed	1.107	0.295	1.501	91.000	0.137	7.396	4.927	-2.391	17.182
	Equal variances not assumed			1.336	26.325	0.193	7.396	5.536	-3.977	18.768
TOT.OPER	Equal variances assumed	2.683	0.105	1.640	91.000	0.005	5.342	3.256	-1.127	11.810
	Equal variances not assumed			1.393	25.140	0.006	5.342	3.835	-2.554	13.237
MARK.EFF	Equal variances assumed	0.064	0.801	0.047	91.000	0.962	0.311	6.585	-12.768	13.391
	Equal variances not assumed			0.046	29.143	0.964	0.311	6.772	-13.536	14.159

Descriptive

	Man. Exec systems	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	8	85.46446	20.57294	7.273633
	no	85	71.8925	18.44289	2.000412
ROOM4	yes	8	89.38011	19.26796	6.812251
	no	85	82.20637	17.31996	1.878613
FB4	yes	8	74.24184	18.68238	6.60522
	no	85	73.92484	19.84836	2.152857
TOT.OPER	yes	8	98.71839	3.624947	1.281612
	no	85	89.76105	13.32689	1.445504
MARK.EFF	yes	8	61.49419	27.39815	9.686709
	no	85	44.11714	25.46719	2.762305

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.505	0.479	1.971	91.000	0.052	13.572	6.884	-0.103	27.247
	Equal variances not assumed			1.799	8.095	0.109	13.572	7.544	-3.788	30.932
ROOM4	Equal variances assumed	0.002	0.968	1.110	91.000	0.270	7.174	6.463	-5.665	20.013
	Equal variances not assumed			1.015	8.101	0.339	7.174	7.067	-9.086	23.434
FB4	Equal variances assumed	1.552	0.216	0.043	91.000	0.965	0.317	7.308	-14.199	14.833
	Equal variances not assumed			0.046	8.558	0.965	0.317	6.947	-15.523	16.157
TOT.OPER	Equal variances assumed	9.433	0.003	1.886	91.000	0.043	8.957	4.750	-0.477	18.392
	Equal variances not assumed			4.637	31.843	0.000	8.957	1.932	5.022	12.893
MARK.EFF	Equal variances assumed	0.006	0.937	1.834	91.000	0.070	17.377	9.475	-1.444	36.198
	Equal variances not assumed			1.725	8.180	0.122	17.377	10.073	-5.762	40.516

Non- parametric tests

Ranks				
	Man. Exec. system	N	Mean Rank	Sum of Ranks
TOT.OPER	No	85	45.24706	3846
	Yes	8	65.625	525
	Total	93		

Test Statistics	
	TOT.OPER
Mann-Whitney U	191
Wilcoxon W	3846
Z	-2.18755
Asymp. Sig. (2-tailed)	0.028703

Descriptive

	Conf. & banq. systems	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	33	80.205	19.09912	3.32473
	no	60	69.13022	17.75406	2.292039
ROOM4	yes	33	85.82644	18.28437	3.182901
	no	60	81.17183	16.98155	2.192309
FB4	yes	33	74.18849	20.28435	3.531052
	no	60	73.82211	19.47052	2.513633
TOT.OPER	yes	33	94.37322	11.52174	2.005678
	no	60	88.41866	13.40037	1.729981
MARK.EFF	yes	33	47.49064	26.57573	4.62624
	no	60	44.57866	25.76356	3.326062

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.922	0.339	2.802	91.000	0.006	11.075	3.953	3.223	18.926
	Equal variances not assumed			2.742	62.044	0.008	11.075	4.038	3.003	19.147
ROOM4	Equal variances assumed	0.011	0.917	1.231	91.000	0.222	4.655	3.782	-2.858	12.167
	Equal variances not assumed			1.204	61.997	0.233	4.655	3.865	-3.071	12.380
FB4	Equal variances assumed	0.285	0.595	0.086	91.000	0.932	0.366	4.283	-8.140	8.873
	Equal variances not assumed			0.085	63.768	0.933	0.366	4.334	-8.293	9.026
TOT.OPER	Equal variances assumed	2.292	0.133	2.151	91.000	0.034	5.955	2.768	0.457	11.453
	Equal variances not assumed			2.248	74.855	0.028	5.955	2.649	0.678	11.231
MARK.EFF	Equal variances assumed	0.253	0.616	0.516	91.000	0.607	2.912	5.646	-8.303	14.127
	Equal variances not assumed			0.511	64.312	0.611	2.912	5.698	-8.470	14.294

Descriptive

	FB systems	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	41	74.26999	17.25304	2.694472
	no	52	72.10594	20.22775	2.805084
ROOM4	yes	41	81.11038	18.88361	2.949124
	no	52	84.17417	16.38665	2.27242
FB4	yes	41	77.89539	19.67623	3.07291
	no	52	70.84299	19.25578	2.670296
TOT.OPER	yes	41	93.81318	11.47271	1.791737
	no	52	87.94415	13.67906	1.896944
MARK.EFF	yes	41	51.46559	27.62635	4.314512
	no	52	40.99656	23.80553	3.301233

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	1.764	0.187	0.546	91.000	0.586	2.164	3.964	-5.709	10.037
	Equal variances not assumed			0.556	90.403	0.579	2.164	3.890	-5.563	9.891
ROOM4	Equal variances assumed	3.792	0.055	-0.837	91.000	0.405	-3.064	3.661	-10.336	4.208
	Equal variances not assumed			-0.823	79.593	0.413	-3.064	3.723	-10.474	4.346
FB4	Equal variances assumed	0.329	0.568	1.737	91.000	0.086	7.052	4.061	-1.013	15.118
	Equal variances not assumed			1.732	85.141	0.087	7.052	4.071	-1.042	15.146
TOT.OPER	Equal variances assumed	1.757	0.188	2.203	91.000	0.030	5.869	2.664	0.577	11.161
	Equal variances not assumed			2.249	90.625	0.027	5.869	2.609	0.686	11.052
MARK.EFF	Equal variances assumed	0.938	0.335	1.961	91.000	0.053	10.469	5.337	-0.133	21.071
	Equal variances not assumed			1.927	79.243	0.058	10.469	5.433	-0.344	21.282

Descriptive

	Stock & inventory systems	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	47	77.90357	18.48856	2.696833
	no	45	67.61162	18.09799	2.697888
ROOM4	yes	47	86.93406	16.50686	2.407774
	no	45	78.35766	17.76593	2.648389
FB4	yes	47	74.75191	20.15823	2.94038
	no	45	72.93113	19.48036	2.903961
TOT.OPER	yes	47	92.86144	11.58209	1.689421
	no	45	87.12494	14.22998	2.12128
MARK.EFF	yes	47	49.75728	27.85973	4.063759
	no	45	41.11493	23.58015	3.515121

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.491	0.485	2.697	90.000	0.008	10.292	3.816	2.710	17.874
	Equal variances not assumed			2.698	89.954	0.008	10.292	3.815	2.713	17.870
ROOM4	Equal variances assumed	1.272	0.262	2.400	90.000	0.018	8.576	3.574	1.477	15.676
	Equal variances not assumed			2.396	88.780	0.019	8.576	3.579	1.464	15.689
FB4	Equal variances assumed	0.145	0.704	0.440	90.000	0.661	1.821	4.136	-6.396	10.037
	Equal variances not assumed			0.441	89.991	0.661	1.821	4.133	-6.389	10.031
TOT.OPER	Equal variances assumed	2.285	0.134	1.754	90.000	0.050	4.736	2.700	-0.627	10.100
	Equal variances not assumed			1.747	84.862	0.014	4.736	2.712	-0.655	10.128
MARK.EFF	Equal variances assumed	3.012	0.086	1.603	90.000	0.113	8.642	5.393	-2.071	19.356
	Equal variances not assumed			1.608	88.684	0.111	8.642	5.373	-2.034	19.319

Descriptive

	EPOS	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	59	77.4119	18.19295	2.36852
	no	34	65.50812	17.9459	3.077696
ROOM4	yes	59	85.89122	16.50267	2.148465
	no	34	77.50001	18.14007	3.110997
FB4	yes	59	75.60237	19.66563	2.560248
	no	34	71.08843	19.59137	3.359892
TOT.OPER	yes	59	92.84084	12.32921	1.605126
	no	34	86.52432	13.39424	2.297093
MARK.EFF	yes	59	45.1175	25.01114	3.256173
	no	34	46.46994	27.864	4.778637

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.652	0.422	3.054	91.000	0.003	11.904	3.898	4.161	19.647
	Equal variances not assumed			3.065	69.744	0.003	11.904	3.884	4.158	19.650
ROOM4	Equal variances assumed	1.482	0.227	2.277	91.000	0.025	8.391	3.685	1.071	15.711
	Equal variances not assumed			2.219	63.735	0.030	8.391	3.781	0.838	15.945
FB4	Equal variances assumed	0.016	0.900	1.067	91.000	0.289	4.514	4.229	-3.886	12.913
	Equal variances not assumed			1.069	69.178	0.289	4.514	4.224	-3.913	12.941
TOT.OPER	Equal variances assumed	1.702	0.195	2.305	91.000	0.023	6.317	2.740	0.874	11.759
	Equal variances not assumed			2.254	64.363	0.028	6.317	2.802	0.719	11.914
MARK.EFF	Equal variances assumed	0.682	0.411	-0.241	91.000	0.810	-1.352	5.616	-12.508	9.803
	Equal variances not assumed			-0.234	63.028	0.816	-1.352	5.783	-12.908	10.203

Descriptive

	Automated mini bars	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	7	77.04385	20.21762	7.641543
	no	86	72.73571	18.88313	2.03622
ROOM4	yes	7	82.90612	20.31931	7.679976
	no	86	82.81674	17.387	1.874889
FB4	yes	7	91.558	16.81894	6.356963
	no	86	72.51907	19.24845	2.075614
TOT.OPER	yes	7	96.18052	10.1054	3.819481
	no	86	90.07177	13.17005	1.420163
MARK.EFF	yes	7	51.98647	30.38559	11.48467
	no	86	45.09308	25.68949	2.770169

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.154	0.696	0.578	91.000	0.565	4.308	7.458	-10.506	19.122
	Equal variances not assumed			0.545	6.880	0.603	4.308	7.908	-14.458	23.074
ROOM4	Equal variances assumed	0.455	0.502	0.013	91.000	0.990	0.089	6.916	-13.648	13.827
	Equal variances not assumed			0.011	6.735	0.991	0.089	7.906	-18.754	18.933
FB4	Equal variances assumed	1.684	0.198	2.536	91.000	0.013	19.039	7.506	4.129	33.949
	Equal variances not assumed			2.847	7.342	0.024	19.039	6.687	3.374	34.704
TOT.OPER	Equal variances assumed	1.653	0.202	1.196	91.000	0.235	6.109	5.106	-4.033	16.251
	Equal variances not assumed			1.499	7.763	0.173	6.109	4.075	-3.338	15.556
MARK.EFF	Equal variances assumed	0.455	0.502	0.674	91.000	0.502	6.893	10.229	-13.425	27.212
	Equal variances not assumed			0.583	6.717	0.579	6.893	11.814	-21.283	35.070

Descriptive

	In-room office fac.	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	36	74.79444	19.71263	2.523944
	no	57	69.75366	17.06979	3.017541
ROOM4	yes	36	84.52053	17.8388	2.284025
	no	57	79.58844	16.62636	2.939154
FB4	yes	36	75.16303	19.21707	2.460494
	no	57	71.64379	20.57141	3.636546
TOT.OPER	yes	36	90.96205	13.92579	1.783015
	no	57	89.71098	11.258	1.990152
MARK.EFF	yes	36	47.66566	27.67889	3.543918
	no	57	41.69704	22.16367	3.91802

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	1.299	0.257	1.225	91.000	0.224	5.041	4.115	-3.134	13.215
	Equal variances not assumed			1.281	71.474	0.204	5.041	3.934	-2.802	12.884
ROOM4	Equal variances assumed	0.608	0.437	1.296	91.000	0.198	4.932	3.806	-2.627	12.492
	Equal variances not assumed			1.325	67.103	0.190	4.932	3.722	-2.497	12.362
FB4	Equal variances assumed	0.308	0.580	0.819	91.000	0.415	3.519	4.298	-5.017	12.056
	Equal variances not assumed			0.802	59.443	0.426	3.519	4.391	-5.265	12.304
TOT.OPER	Equal variances assumed	1.570	0.213	0.438	91.000	0.662	1.251	2.855	-4.419	6.921
	Equal variances not assumed			0.468	75.580	0.641	1.251	2.672	-4.071	6.573
MARK.EFF	Equal variances assumed	3.161	0.079	1.054	91.000	0.294	5.969	5.660	-5.275	17.212
	Equal variances not assumed			1.130	76.143	0.262	5.969	5.283	-4.553	16.490

Descriptive

	TV based services	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	28	73.06507	17.99958	3.401602
	no	65	73.05779	19.41879	2.408604
ROOM4	yes	28	86.96403	15.76461	2.979232
	no	65	81.03984	18.01757	2.234805
FB4	yes	28	72.42978	20.65087	3.902647
	no	65	74.60788	19.33632	2.398375
TOT.OPER	yes	28	92.89886	9.389282	1.774407
	no	65	89.51182	14.24821	1.767273
MARK.EFF	yes	28	44.42947	23.86967	4.510943
	no	65	46.12131	26.95584	3.34346

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.796	0.375	0.002	91.000	0.999	0.007	4.297	-8.528	8.543
	Equal variances not assumed			0.002	55.026	0.999	0.007	4.168	-8.345	8.360
ROOM4	Equal variances assumed	1.426	0.236	1.508	91.000	0.135	5.924	3.929	-1.880	13.728
	Equal variances not assumed			1.591	58.165	0.117	5.924	3.724	-1.530	13.379
FB4	Equal variances assumed	0.267	0.607	-0.488	91.000	0.627	-2.178	4.461	-11.040	6.684
	Equal variances not assumed			-0.475	48.337	0.637	-2.178	4.581	-11.387	7.030
TOT.OPER	Equal variances assumed	4.326	0.040	1.153	91.000	0.252	3.387	2.938	-2.449	9.223
	Equal variances not assumed			1.352	75.707	0.180	3.387	2.504	-1.601	8.375
MARK.EFF	Equal variances assumed	1.185	0.279	-0.287	91.000	0.775	-1.692	5.895	-13.402	10.018
	Equal variances not assumed			-0.301	57.494	0.764	-1.692	5.615	-12.933	9.550

Non-parametric

Ranks

	TV based services	N	Mean Rank	Sum of Ranks
TOT.OPER	No	65	45.72308	2972
	Yes	28	49.96429	1399
	Total	93		

Test Statistics

	TOT.OPER
Mann-Whitney U	827
Wilcoxon W	2972
Z	-0.74485
Asymp. Sig. (2-tailed)	0.456363

Descriptive

	Voice mail	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	30	73.99918	19.22646	3.510256
	no	63	72.61274	18.88941	2.379842
ROOM4	yes	30	79.89782	19.93572	3.639749
	no	63	84.21663	16.19879	2.040855
FB4	yes	30	75.7255	20.86479	3.809372
	no	63	73.10764	19.16493	2.414554
TOT.OPER	yes	30	92.79518	13.25641	2.420278
	no	63	89.45366	12.87306	1.621854
MARK.EFF	yes	30	47.63163	26.2949	4.800769
	no	63	44.65019	25.93764	3.267835

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.125	0.724	0.329	91.000	0.743	1.386	4.214	-6.984	9.757
	Equal variances not assumed			0.327	56.229	0.745	1.386	4.241	-7.108	9.881
ROOM4	Equal variances assumed	4.612	0.034	-1.114	91.000	0.268	-4.319	3.877	-12.020	3.382
	Equal variances not assumed			-1.035	47.888	0.306	-4.319	4.173	-12.709	4.072
FB4	Equal variances assumed	1.774	0.186	0.598	91.000	0.551	2.618	4.375	-6.072	11.308
	Equal variances not assumed			0.580	52.983	0.564	2.618	4.510	-6.428	11.664
TOT.OPER	Equal variances assumed	0.023	0.880	1.159	91.000	0.249	3.342	2.883	-2.385	9.068
	Equal variances not assumed			1.147	55.644	0.256	3.342	2.913	-2.496	9.179
MARK.EFF	Equal variances assumed	0.012	0.911	0.516	91.000	0.607	2.981	5.779	-8.498	14.461
	Equal variances not assumed			0.513	56.433	0.610	2.981	5.807	-8.650	14.613

Non-parametric

Ranks

	Voice mail	N	Mean Rank	Sum of Ranks
ROOM4	No	63	48.61111	3062.5
	Yes	30	43.61666	1308.5
	Total	93		

Test Statistics

	ROOM4
Mann-Whitney U	843.5
Wilcoxon W	1308.5
Z	-0.8517
Asymp. Sig. (2-tailed)	0.394382

Descriptive

	On demand movies	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	26	75.34883	18.11537	3.552717
	no	67	72.17177	19.26218	2.353249
ROOM4	yes	26	88.61258	14.83268	2.908927
	no	67	80.57695	18.03353	2.203147
FB4	yes	26	72.92489	20.34938	3.990842
	no	67	74.35074	19.51917	2.384646
TOT.OPER	yes	26	93.50987	9.595943	1.881919
	no	67	89.37581	14.02128	1.712972
MARK.EFF	yes	26	48.09829	25.86279	5.072111
	no	67	44.64709	26.11102	3.189969

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.337	0.563	0.725	91.000	0.470	3.177	4.379	-5.522	11.876
	Equal variances not assumed			0.746	48.233	0.460	3.177	4.261	-5.390	11.744
ROOM4	Equal variances assumed	3.494	0.065	2.020	91.000	0.046	8.036	3.977	0.135	15.936
	Equal variances not assumed			2.202	55.046	0.032	8.036	3.649	0.723	15.348
FB4	Equal variances assumed	0.243	0.623	-0.312	91.000	0.755	-1.426	4.564	-10.491	7.639
	Equal variances not assumed			-0.307	43.918	0.761	-1.426	4.649	-10.796	7.944
TOT.OPER	Equal variances assumed	3.011	0.086	1.381	91.000	0.171	4.134	2.994	-1.813	10.081
	Equal variances not assumed			1.625	66.338	0.109	4.134	2.545	-0.946	9.214
MARK.EFF	Equal variances assumed	0.020	0.887	0.574	91.000	0.568	3.451	6.017	-8.502	15.404
	Equal variances not assumed			0.576	45.965	0.567	3.451	5.992	-8.610	15.512

Descriptive

	In-room internet	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	28	70.86426	20.80878	3.93249
	no	65	74.00583	18.11294	2.246633
ROOM4	yes	28	76.41865	20.80379	3.931546
	no	65	85.58246	15.22977	1.88902
FB4	yes	28	72.13242	21.04335	3.976819
	no	65	74.73598	19.14073	2.374115
TOT.OPER	yes	28	90.29292	14.65896	2.770282
	no	65	90.63438	12.37017	1.534331
MARK.EFF	yes	28	49.57591	25.56699	4.831706
	no	65	43.90439	26.12005	3.239794

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	2.001	0.161	-0.733	91.000	0.465	-3.142	4.284	-11.652	5.369
	Equal variances not assumed			-0.694	45.458	0.491	-3.142	4.529	-12.261	5.978
ROOM4	Equal variances assumed	11.928	0.001	-2.374	91.000	0.020	-9.164	3.860	-16.831	-1.497
	Equal variances not assumed			-2.101	40.006	0.042	-9.164	4.362	-17.979	-0.348
FB4	Equal variances assumed	0.179	0.673	-0.584	91.000	0.561	-2.604	4.459	-11.460	6.253
	Equal variances not assumed			-0.562	47.148	0.577	-2.604	4.632	-11.920	6.713
TOT.OPER	Equal variances assumed	2.881	0.093	-0.115	91.000	0.908	-0.341	2.959	-6.220	5.537
	Equal variances not assumed			-0.108	44.345	0.915	-0.341	3.167	-6.722	6.039
MARK.EFF	Equal variances assumed	0.309	0.580	0.967	91.000	0.336	5.672	5.868	-5.984	17.327
	Equal variances not assumed			0.975	52.278	0.334	5.672	5.817	-6.000	17.343

Non-parametric tests

Ranks				
	In room internet	**N**	**Mean Rank**	**Sum of Ranks**
ROOM4	No	65	50.56154	3286.5
	Yes	28	38.73214	1084.5
	Total	93		

Test Statistics	
	ROOM4
Mann-Whitney U	678.5
Wilcoxon W	1084.5
Z	-1.97955
Asymp. Sig. (2-tailed)	0.047755

Descriptive

	e-procur.	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
ROOM3	yes	6	78.57757	17.12164	6.989881
	no	87	72.67946	19.05326	2.042724
ROOM4	yes	6	83.28701	14.71084	6.005676
	no	87	82.7915	17.74825	1.902812
FB4	yes	6	85.42345	20.09618	8.20423
	no	87	73.16099	19.49153	2.089711
TOT.OPER	yes	6	96.46208	6.482926	2.646644
	no	87	90.12257	13.27781	1.42353
MARK.EFF	yes	6	51.56031	26.36622	10.76396
	no	87	45.20171	26.0233	2.78999

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.309	0.580	0.737	91.000	0.463	5.898	8.000	-9.992	21.788
	Equal variances not assumed			0.810	5.888	0.449	5.898	7.282	-12.003	23.800
ROOM4	Equal variances assumed	1.073	0.303	0.067	91.000	0.947	0.496	7.427	-14.257	15.248
	Equal variances not assumed			0.079	6.051	0.940	0.496	6.300	-14.889	15.880
FB4	Equal variances assumed	0.388	0.535	1.488	91.000	0.140	12.262	8.241	-4.108	28.633
	Equal variances not assumed			1.448	5.668	0.200	12.262	8.466	-8.751	33.276
TOT.OPER	Equal variances assumed	3.382	0.069	1.156	91.000	0.251	6.340	5.486	-4.558	17.237
	Equal variances not assumed			2.110	8.271	0.067	6.340	3.005	-0.551	13.230
MARK.EFF	Equal variances assumed	0.004	0.949	0.578	91.000	0.564	6.359	10.992	-15.476	28.193
	Equal variances not assumed			0.572	5.693	0.589	6.359	11.120	-21.210	33.927

Descriptive

	e-lock system	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	41	75.02529	18.69348	2.91943
	no	52	71.51041	19.10767	2.649757
ROOM4	yes	41	85.98816	16.33448	2.551017
	no	52	80.32822	18.13158	2.514397
FB4	yes	41	75.45147	20.94011	3.270296
	no	52	72.76992	18.69885	2.593064
TOT.OPER	yes	41	94.41129	8.874291	1.385931
	no	52	87.47256	14.91392	2.068189
MARK.EFF	yes	41	47.13189	22.88476	3.574
	no	52	44.41353	28.29299	3.923532

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.045	0.832	0.889	91.000	0.376	3.515	3.953	-4.337	11.367
	Equal variances not assumed			0.892	86.832	0.375	3.515	3.943	-4.322	11.351
ROOM4	Equal variances assumed	1.242	0.268	1.561	91.000	0.122	5.660	3.627	-1.544	12.864
	Equal variances not assumed			1.580	89.339	0.118	5.660	3.582	-1.457	12.777
FB4	Equal variances assumed	1.694	0.196	0.651	91.000	0.517	2.682	4.118	-5.498	10.861
	Equal variances not assumed			0.643	80.997	0.522	2.682	4.174	-5.623	10.986
TOT.OPER	Equal variances assumed	10.314	0.002	2.632	91.000	0.010	6.939	2.636	1.703	12.174
	Equal variances not assumed			2.787	85.186	0.007	6.939	2.490	1.989	11.889
MARK.EFF	Equal variances assumed	3.130	0.080	0.500	91.000	0.619	2.718	5.442	-8.091	13.527
	Equal variances not assumed			0.512	90.928	0.610	2.718	5.307	-7.824	13.261

Non-parametric tests

Ranks				
	e-lock system	N	Mean Rank	Sum of Ranks
TOT.OPER	No	52	41.32692	2149
	Yes	41	54.19512	2222
	Total	93		

Test Statistics	
	TOT.OPER
Mann-Whitney U	771
Wilcoxon W	2149
Z	-2.44599
Asymp. Sig. (2-tailed)	0.014446

Descriptive

	Energy manag	N	Mean	Std. Deviation	Std. Error Mean
ROOM3	yes	11	77.17256	19.56657	5.899542
	no	82	72.50829	18.86986	2.083828
ROOM4	yes	11	79.9387	19.99353	6.028276
	no	82	83.21045	17.23914	1.903745
FB4	yes	11	82.29607	18.87329	5.690512
	no	82	72.8328	19.59648	2.164069
TOT.OPER	yes	11	96.63514	7.641084	2.303874
	no	82	89.7128	13.4021	1.480014
MARK.EFF	yes	11	47.47761	31.91356	9.6223
	no	82	45.36167	25.26767	2.790348

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.208	0.649	0.767	91.000	0.445	4.664	6.084	-7.421	16.750
	Equal variances not assumed			0.745	12.627	0.470	4.664	6.257	-8.893	18.222
ROOM4	Equal variances assumed	1.510	0.222	-0.580	91.000	0.563	-3.272	5.639	-14.474	7.930
	Equal variances not assumed			-0.518	12.079	0.614	-3.272	6.322	-17.036	10.492
FB4	Equal variances assumed	0.007	0.936	1.510	91.000	0.135	9.463	6.267	-2.986	21.912
	Equal variances not assumed			1.554	13.068	0.144	9.463	6.088	-3.682	22.609
TOT.OPER	Equal variances assumed	4.454	0.038	1.672	91.000	0.048	6.922	4.141	-1.303	15.147
	Equal variances not assumed			2.528	19.546	0.020	6.922	2.738	1.202	12.643
MARK.EFF	Equal variances assumed	2.296	0.133	0.253	91.000	0.801	2.116	8.375	-14.519	18.751
	Equal variances not assumed			0.211	11.742	0.836	2.116	10.019	-19.766	23.998

Non-parametric tests

Ranks				
	Energy manag.	**N**	**Mean Rank**	**Sum of Ranks**
TOT.OPER	No	82	45.09756	3698
	Yes	11	61.18182	673
	Total	93		

Test Statistics	
	TOT.OPER
Mann-Whitney U	295
Wilcoxon W	3698
Z	-1.9886
Asymp. Sig. (2-tailed)	0.046746

Descriptive

	Videoconf. systems	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
ROOM3	yes	5	77.99998	20.16336	9.017329
	no	88	72.7793	18.91485	2.01633
ROOM4	yes	5	79.7899	18.8068	8.410659
	no	88	82.99583	17.52176	1.867826
FB4	yes	5	97.78671	4.751711	2.12503
	no	88	72.59787	19.31119	2.05858
TOT.OPER	yes	5	100	1.67E-08	7.47E-09
	no	88	89.99359	13.18472	1.405496
MARK.EFF	yes	5	39.15707	31.94485	14.28617
	no	88	45.9787	25.73986	2.743878

t-test

		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ROOM3	Equal variances assumed	0.099	0.753	0.599	91.000	0.551	5.221	8.722	-12.104	22.546
	Equal variances not assumed			0.565	4.409	0.600	5.221	9.240	-19.521	29.962
ROOM4	Equal variances assumed	0.035	0.853	-0.397	91.000	0.693	-3.206	8.082	-19.261	12.849
	Equal variances not assumed			-0.372	4.404	0.727	-3.206	8.616	-26.286	19.874
FB4	Equal variances assumed	8.681	0.004	2.898	91.000	0.005	25.189	8.693	7.921	42.456
	Equal variances not assumed			8.514	14.445	0.000	25.189	2.959	18.862	31.516
TOT.OPER	Equal variances assumed	9.151	0.003	1.688	91.000	0.049	10.006	5.927	-1.767	21.779
	Equal variances not assumed			7.119	87.000	0.000	10.006	1.405	7.213	12.800
MARK.EFF	Equal variances assumed	0.567	0.453	-0.570	91.000	0.570	-6.822	11.973	-30.605	16.962
	Equal variances not assumed			-0.469	4.300	0.662	-6.822	14.547	-46.123	32.480

Non-parametric tests

Ranks				
	Videoconf. systems	N	**Mean Rank**	**Sum of Ranks**
FB4	No	88	45.17614	3975.5
	Yes	5	79.1	395.5
	Total	93		
TOT.OPER	No	88	45.69318	4021
	Yes	5	70	350
	Total	93		

Test Statistics		
	FB4	TOT.OPER
Mann-Whitney U	59.5	105
Wilcoxon W	3975.5	4021
Z	-2.74379	-2.09893
Asymp. Sig. (2-tailed)	0.006073	0.035823

F.1.2 chi-square tests for investigating the effect of ICT availability on market efficiency in rooms division

			PMS		Total
			no	yes	
MARK.ONL	inefficient	Count	9	51	60
		% within PMS	60	65.38462	64.51613
	efficient	Count	6	27	33
		% within PMS	40	34.61538	35.48387
Total		Count	15	78	93
		% within PMS	100	100	100

	Value	**df**	**Asymp. Sig. (2-sided)**	**Exact Sig. (2-sided)**	**Exact Sig. (1-sided)**
Pearson Chi-Square	0.159336	1	0.689769		
Continuity Correction	0.010929	1	0.916738		
Likelihood Ratio	0.157138	1	0.691806		
Fisher's Exact Test				1	0.758862
Linear-by-Linear Association	0.157622	1	0.691355		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.32.

			Intranet		Total
			no	yes	
MARK.ONL	inefficient	Count	46	14	60
		% within Intranet	73.01587	46.66667	64.51613
	efficient	Count	17	16	33
		% within Intranet	26.98413	53.33333	35.48387
Total		Count	63	30	93
		% within Intranet	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.163319	1	0.013043		
Continuity Correction	5.066073	1	0.024399		
Likelihood Ratio	6.046547	1	0.013934		
Fisher's Exact Test				0.019898	0.012752
Linear-by-Linear Association	6.097047	1	0.013541		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.65.

			database		Total
			no	yes	
MARK. ONL	inefficient	Count	21	39	60
		% within O.24	80.76923	58.20896	64.51613
	efficient	Count	5	28	33
		% within O.24	19.23077	41.79104	35.48387
Total		Count	26	67	93
		% within O.24	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.164422	1	0.051282		
Continuity Correction	3.237249	1	0.071981		
Likelihood Ratio	4.448411	1	0.050934		
Fisher's Exact Test				0.053811	0.033347
Linear-by-Linear Association	4.119643	1	0.042388		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.23.

			Yield		Total
			no	yes	
MARK. ONL	inefficient	Count	32	28	60
		% within O.2	71.11111	58.33333	64.51613
	efficient	Count	13	20	33
		% within O.2	28.88889	41.66667	35.48387
Total		Count	45	48	93
		% within O.2	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.656465	1	0.198081		
Continuity Correction	1.145327	1	0.28453		
Likelihood Ratio	1.666263	1	0.19676		
Fisher's Exact Test				0.278279	0.142225
Linear-by-Linear Association	1.638653	1	0.20051		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.97.

			GDS		Total
			no	yes	
MARK. ONL	inefficient	Count	32	28	60
		% within O.1	69.56522	59.57447	64.51613
	efficient	Count	14	19	33
		% within O.1	30.43478	40.42553	35.48387
Total		Count	46	47	93
		% within O.1	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.013607	1	0.31404		
Continuity Correction	0.624168	1	0.429503		
Likelihood Ratio	1.016613	1	0.313324		
Fisher's Exact Test				0.387577	0.214907
Linear-by-Linear Association	1.002708	1	0.316656		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 16.32.

			CRS		Total
			no	yes	
MARK. ONL	inefficien	Count	23	37	60
		% within O.28	76.66667	58.73016	64.51613
	efficient	Count	7	26	33
		% within O.28	23.33333	41.26984	35.48387
Total		Count	30	63	93
		% within O.28	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.855981	1	0.091035		
Continuity Correction	2.126218	1	0.144798		
Likelihood Ratio	2.970262	1	0.084808		
Fisher's Exact Test				0.108551	0.070718
Linear-by-Linear Association	2.825272	1	0.092791		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.65.

			PBRS		Total
			no	yes	
MARK. ONL	inefficien	Count	16	44	60
		% within O.3	69.56522	62.85714	64.51613
	efficient	Count	7	26	33
		% within O.3	30.43478	37.14286	35.48387
Total		Count	23	70	93
		% within O.3	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.340282	1	0.559666		
Continuity Correction	0.110342	1	0.739755		
Likelihood Ratio	0.34588	1	0.556454		
Fisher's Exact Test				0.6232	0.374462
Linear-by-Linear Association	0.336623	1	0.561785		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.16.

			Marketing & sales systems		Total
			no	yes	
MARK. ONL	ine ffic ien t	Count	35	25	60
		% within O.26	66.03774	62.5	64.51613
	effi cie nt	Count	18	15	33
		% within O.26	33.96226	37.5	35.48387
Total		Count	53	40	93
		% within O.26	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.124625	1	0.724072		
Continuity Correction	0.017996	1	0.893285		
Likelihood Ratio	0.124405	1	0.724305		
Fisher's Exact Test				1	0.71681
Linear-by-Linear Association	0.123285	1	0.725499		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.19.

			Front office system		Total
			no	yes	
MARK. ONL	inefficient	Count	5	55	60
		% within O.27	71.42857	63.95349	64.51613
	efficient	Count	2	31	33
		% within O.27	28.57143	36.04651	35.48387
Total		Count	7	86	93
		% within O.27	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.157996	1	0.691008		
Continuity Correction	0	1	1		
Likelihood Ratio	0.163007	1	0.686403		
Fisher's Exact Test				1	0.519547
Linear-by-Linear Association	0.156297	1	0.692589		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.48.

			Telephone system		Total
			no	yes	
MARK. ONL	inefficient	Count	14	46	60
		% within O.20	77.77778	61.33333	64.51613
	efficient	Count	4	29	33
		% within O.20	22.22222	38.66667	35.48387
Total		Count	18	75	93
		% within O.20	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.714707	1	0.190376		
Continuity Correction	1.071614	1	0.300581		
Likelihood Ratio	1.818186	1	0.177529		
Fisher's Exact Test				0.27404	0.150042
Linear-by-Linear Association	1.696269	1	0.192777		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.39.

			Check in/out kiosks		Total
			no	yes	
MARK. ONL	inefficient	Count	55	5	60
		% within O.4	67.07317	45.45455	64.51613
	efficient	Count	27	6	33
		% within O.4	32.92683	54.54545	35.48387
Total		Count	82	11	93
		% within O.4	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.98007	1	0.159383		
Continuity Correction	1.148323	1	0.2839		
Likelihood Ratio	1.894341	1	0.168713		
Fisher's Exact Test				0.188837	0.142403
Linear-by-Linear Association	1.958778	1	0.161644		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.90.

			HRM		Total
			no	yes	
MARK. ONL	inefficient	Count	50	10	60
		% within O.5	65.78947	58.82353	64.51613
	efficient	Count	26	7	33
		% within O.5	34.21053	41.17647	35.48387
Total		Count	76	17	93
		% within O.5	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.294469	1	0.587371		
Continuity Correction	0.068791	1	0.793105		
Likelihood Ratio	0.289702	1	0.590411		
Fisher's Exact Test				1	0.796149
Linear-by-Linear Association	0.291303	1	0.589387		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.03.

			F&A		Total
			no	yes	
MARK. ONL	inefficient	Count	15	45	60
		% within O.6	75	61.64384	64.51613
	efficient	Count	5	28	33
		% within O.6	25	38.35616	35.48387
Total		Count	20	73	93
		% within O.6	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.223303	1	0.268713		
Continuity Correction	0.709443	1	0.399629		
Likelihood Ratio	1.275252	1	0.258784		
Fisher's Exact Test				0.304943	0.201376
Linear-by-Linear Association	1.210149	1	0.271303		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.10.

			Manag & executive systems		Total
			no	yes	
MARK. ONL	inefficient	Count	57	3	60
		% within O.22	67.05882	37.5	64.51613
	efficient	Count	28	5	33
		% within O.22	32.94118	62.5	35.48387
Total		Count	85	8	93
		% within O.22	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.790622	1	0.094817		
Continuity Correction	1.648792	1	0.199123		
Likelihood Ratio	2.648231	1	0.103665		
Fisher's Exact Test				0.126774	0.101651
Linear-by-Linear Association	2.760615	1	0.096611		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.84.

			Conference & banqueting systems		Total
			no	yes	
MARK. ONL	inefficient	Count	43	17	60
		% within O.7	71.66667	51.51515	64.51613
	efficient	Count	17	16	33
		% within O.7	28.33333	48.48485	35.48387
Total		Count	60	33	93
		% within O.7	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.776577	1	0.051975		
Continuity Correction	2.947615	1	0.086004		
Likelihood Ratio	3.726369	1	0.05356		
Fisher's Exact Test				1	0.984543
Linear-by-Linear Association	3.735969	1	0.053253		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.71.

			F&B systems		Total
			no	yes	
MARK. ONL	inefficient	Count	34	26	60
		% within O.8	65.38462	63.41463	64.51613
	efficient	Count	18	15	33
		% within O.8	34.61538	36.58537	35.48387
Total		Count	52	41	93
		% within O.8	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.038862	1	0.843722		
Continuity Correction	0	1	1		
Likelihood Ratio	0.038828	1	0.84379		
Fisher's Exact Test				1	0.661671
Linear-by-Linear Association	0.038444	1	0.844553		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.55.

			Stock & inventory systems		Total
			no	yes	
MARK. ONL	inefficient	Count	33	27	60
		% within O.9	73.33333	56.25	64.51613
	efficient	Count	12	21	33
		% within O.9	26.66667	43.75	35.48387
Total		Count	45	48	93
		% within O.9	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.960852	1	0.085303		
Continuity Correction	2.26164	1	0.132614		
Likelihood Ratio	2.99013	1	0.083773		
Fisher's Exact Test				0.128504	0.065909
Linear-by-Linear Association	2.929015	1	0.087001		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 15.97.

			EPOS		Total
			no	yes	
MARK. ONL	inefficient	Count	24	36	60
		% within O.10	70.58824	61.01695	64.51613
	efficient	Count	10	23	33
		% within O.10	29.41176	38.98305	35.48387
Total		Count	34	59	93
		% within O.10	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.863156	1	0.352857		
Continuity Correction	0.495693	1	0.481399		
Likelihood Ratio	0.875108	1	0.349545		
Fisher's Exact Test				0.378578	0.241857
Linear-by-Linear Association	0.853875	1	0.355458		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.06.

			Automated mini bars		Total
			no	yes	
MARK. ONL	inefficient	Count	56	4	60
		% within O.11	65.11628	57.14286	64.51613
	efficient	Count	30	3	33
		% within O.11	34.88372	42.85714	35.48387
Total		Count	86	7	93
		% within O.11	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.179764	1	0.671576		
Continuity Correction	0.000176	1	0.989429		
Likelihood Ratio	0.175443	1	0.675319		
Fisher's Exact Test				1	0.800383
Linear-by-Linear Association	0.177831	1	0.673244		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.48.

			In-room office facilities		Total
			no	yes	
MARK. ONL	inefficient	Count	28	29	57
		% within O.12	0.7	0.54717	0.612903
	efficient	Count	12	24	36
		% within O.12	0.3	0.45283	0.382979
Total		Count	40	53	93
		% within O.12	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.342325	1	0.125902		
Continuity Correction	1.696161	1	0.192791		
Likelihood Ratio	2.413753	1	0.120274		
Fisher's Exact Test				0.171684	0.095319
Linear-by-Linear Association	2.317139	1	0.127955		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.35.

			TV based services		Total
			no	yes	
MARK. ONL	inefficient	Count	46	14	60
		% within O.13	70.76923	50	64.51613
	efficient	Count	19	14	33
		% within O.13	29.23077	50	35.48387
Total		Count	65	28	93
		% within O.13	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.687483	1	0.054822		
Continuity Correction	2.836047	1	0.092171		
Likelihood Ratio	3.609762	1	0.057441		
Fisher's Exact Test				0.063117	0.047142
Linear-by-Linear Association	3.647832	1	0.056142		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.94.

			Voice mail		Total
			no	yes	
MARK. ONL	inefficient	Count	41	19	60
		% within O.14	65.07937	63.33333	64.51613
	efficient	Count	22	11	33
		% within O.14	34.92063	36.66667	35.48387
Total		Count	63	30	93
		% within O.14	100	100	100

	Value	df	Asymp. Sig.	Exact Sig. (2-	Exact Sig. (1-

			(2-sided)	sided)	sided)
Pearson Chi-Square	0.027063	1	0.86933		
Continuity Correction	0	1	1		
Likelihood Ratio	0.026995	1	0.869493		
Fisher's Exact Test				1	0.656362
Linear-by-Linear Association	0.026772	1	0.870028		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.65.

			On demand movies		Total
			no	yes	
MARK. ONL	inefficient	Count	47	13	60
		% within O.15	70.14925	50	64.51613
	efficient	Count	20	13	33
		% within O.15	29.85075	50	35.48387
Total		Count	67	26	93
		% within O.15	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.321879	1	0.068364		
Continuity Correction	2.500024	1	0.113845		
Likelihood Ratio	3.24336	1	0.071713		
Fisher's Exact Test				0.091467	0.05812
Linear-by-Linear Association	3.28616	1	0.069866		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.23.

			In-room internet		Total
			no	yes	
MARK. ONL	inefficient	Count	41	19	60
		% within O.16	63.07692	67.85714	64.51613
	efficient	Count	24	9	33
		% within O.16	36.92308	32.14286	35.48387
Total		Count	65	28	93
		% within O.16	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.195337	1	0.658511		
Continuity Correction	0.042331	1	0.836991		
Likelihood Ratio	0.197078	1	0.657089		
Fisher's Exact Test				0.813874	0.422151
Linear-by-Linear Association	0.193237	1	0.660236		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.94.

			e-procurement		Total
			no	yes	
MARK. ONL	inefficient	Count	56	4	60
		% within O.17	64.36782	66.66667	64.51613
	efficient	Count	31	2	33
		% within O.17	35.63218	33.33333	35.48387
Total		Count	87	6	93
		% within O.17	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.012957	1	0.909373		
Continuity Correction	0	1	1		
Likelihood Ratio	0.013073	1	0.908972		
Fisher's Exact Test				1	0.639905
Linear-by-Linear Association	0.012818	1	0.909859		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.13.

			e-lock systems		Total
			no	yes	
MARK. ONL	inefficient	Count	38	22	60
		% within O.18	73.07692	53.65854	64.51613
	efficient	Count	14	19	33
		% within O.18	26.92308	46.34146	35.48387
Total		Count	52	41	93
		% within O.18	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.775994	1	0.051993		
Continuity Correction	2.975399	1	0.084539		
Likelihood Ratio	3.775106	1	0.052021		
Fisher's Exact Test				0.080084	0.04234
Linear-by-Linear Association	3.735391	1	0.053271		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.55.

			Energy management systems		Total
			no	yes	
MARK. ONL	inefficient	Count	54	6	60
		% within O.19	65.85366	54.54545	64.51613
	efficient	Count	28	5	33
		% within O.19	34.14634	45.45455	35.48387
Total		Count	82	11	93
		% within O.19	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.541766	1	0.461702		
Continuity Correction	0.160397	1	0.688791		
Likelihood Ratio	0.526229	1	0.468197		
Fisher's Exact Test				1	0.857597
Linear-by-Linear Association	0.53594	1	0.46412		
N of Valid Cases	93				

a Computed only for a 2x2 table

b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.90.

			Videoconferencing systems		Total
			no	yes	
MARK. ONL	inefficient	Count	57	3	60
		% within O.21	64.77273	60	64.51613
	efficient	Count	31	2	33
		% within O.21	35.22727	40	35.48387
Total		Count	88	5	93
		% within O.21	100	100	100

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.047076	1	0.828231		
Continuity Correction	0	1	1		
Likelihood Ratio	0.046314	1	0.829605		
Fisher's Exact Test				1	0.762375
Linear-by-Linear Association	0.04657	1	0.829143		
N of Valid Cases	93				

A Computed only for a 2x2 table

B 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.77.

Appendix F.2
The productivity impact of cluster of technologies

F.2.1 Pearson Correlations investigating the impact of cluster of technologies on operational productivity in rooms and whole hotel property, on market productivity in whole property and combined productivity in FB and whole hotel property

Number of distribution technologies (1)	Website online reserv., reservations through e-mail, GDS, Property based, CRS
Number of reservation technologies (2)	Technologies in (1), YM, Customer Database, M&S
Number of in-room technologies (3)	Office facil., TV based services, Voice mail, On demand movies, In-room internet access, Automated mini-bars
Number of ICT in Rooms division only (4)	Front Office system, Telephone system, PBRS, CRS, YM, GDS, M&S, Check in/out kiosks, smart cards
Number of ICT in FB division only (5)	Conf. & Banq. systems, FB systems, Stock & Invent. Systems, EPOS
Number of non FB division ICT (6)	(7) - (5)= (4) + (9)
Number of ICT in whole hotel property (7)	27 technologies
Critical success technologies (8)	PMS, Website, Email, Intranet, Extranet, Customer Database
Number of general ICT (9)	F&A, e-lock, HRM, energy mangmt, MSS, e-procurement, Videoconferencing, DSS
Overall number of ICT	(7) + (8)

Cluster		ROOM3	ROOM4	FB4	TOT.OPER	MARK.EFF
(1)	Pearson Correlation	[redacted]	0.144906	0.093667	0.151175	0.233797
	Sig. (2-tailed)	*0.002622*	*0.165794*	*0.371833*	*0.14804*	*0.0241*
(2)	Pearson Correlation	[redacted]	0.159634	0.144895	0.221958	0.212343
	Sig. (2-tailed)	*0.003058*	*0.126399*	*0.165827*	*0.032493*	*0.04101*
(3)	Pearson Correlation	0.060959	0.042569	0.047641	0.149737	0.10352
	Sig. (2-tailed)	*0.561605*	*0.685366*	*0.650206*	*0.151981*	*0.323417*
(4)	Pearson Correlation	0.258744	0.115692	0.015285	0.121616	0.203561
	Sig. (2-tailed)	*0.01227*	*0.269458*	*0.884378*	*0.245531*	*0.05034*
	Pearson Correlation	[redacted]	0.195503	0.132535	[redacted]	0.152508
(5)	*Sig. (2-tailed)*	*0.00066*	*0.060377*	*0.205359*	*0.001559*	*0.144456*
	Pearson Correlation	0.24587	0.160903	0.108434	0.229304	0.153586
(6)	*Sig. (2-tailed)*	*0.01752*	*0.123375*	*0.300852*	*0.027038*	*0.141607*
(7)	Pearson Correlation	[redacted]	0.152814	0.115898	0.256512	0.189496
	Sig. (2-tailed)	*0.003626*	*0.143642*	*0.2686*	*0.013067*	*0.068875*
(8)	Pearson Correlation	0.148123	0.124307	0.068405	0.129861	-0.01622
	Sig. (2-tailed)	*0.156496*	*0.235159*	*0.514712*	*0.214731*	*0.877389*
(7) + (8)	Pearson Correlation	[redacted]	0.183608	0.126289	0.263409	0.168221
	Sig. (2-tailed)	*0.003708*	*0.078117*	*0.227721*	*0.010739*	*0.106999*
	Pearson Correlation	0.231077	0.124574	0.217429	[redacted]	0.102509
(9)	*Sig. (2-tailed)*	*0.025844*	*0.234149*	*0.036298*	*0.002874*	*0.328189*

[redacted] Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

F.2.2 T-Test investigating the impact of clusters of ICT on market efficiency in rooms division

Descriptive

	MARK.ONL	N	Mean	Std. Deviation	Std. Error Mean
(1)	inefficient	60	2.85	1.218849	0.157353
	efficient	33	3.272727	1.17985	0.205385
(2)	inefficient	60	4.366667	2.058193	0.265712
	efficient	33	5.181818	1.991459	0.346669
(3)	inefficient	60	1.75	1.491501	0.192552
	efficient	33	2.272727	1.505671	0.262104
(4)	inefficient	60	4.533333	2.037502	0.26304
	efficient	33	5.242424	2.179884	0.379469
(5)	inefficient	60	1.766667	1.226358	0.158322
	efficient	33	2.272727	1.398051	0.243369
(6)	inefficient	60	11.45	4.724351	0.609911
	efficient	33	13.69697	5.132524	0.893458
(7)	inefficient	60	10.43333	4.865537	0.628138
	efficient	33	12.75758	5.579148	0.971205
(8)	inefficient	60	3.814286	1.006826	0.129981
	efficient	33	4.030303	1.07485	0.187107
(9)	inefficient	60	1.55	1.254483	0.161953
	efficient	33	2.121212	1.615503	0.281223
(7) +(8)	inefficient	60	13.36667	5.498742	0.709884
	efficient	33	15.9697	6.146568	1.06998

t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
(1)	Equal variances assumed	0.001	0.971	-1.618	91.000	0.109	-0.423	0.261	-0.942	0.096
	Equal variances not assumed			-1.634	67.902	0.107	-0.423	0.259	-0.939	0.094
(2)	Equal variances assumed	0.174	0.678	-1.848	91.000	0.068	-0.815	0.441	-1.691	0.061
	Equal variances not assumed			-1.866	67.927	0.066	-0.815	0.437	-1.687	0.056
(3)	Equal variances assumed	0.035	0.851	-1.612	91.000	0.110	-0.523	0.324	-1.167	0.122
	Equal variances not assumed			-1.607	65.512	0.113	-0.523	0.325	-1.172	0.127
(4)	Equal variances assumed	0.083	0.775	-1.566	91.000	0.121	-0.709	0.453	-1.608	0.190
	Equal variances not assumed			-1.536	62.334	0.130	-0.709	0.462	-1.632	0.214
(5)	Equal variances assumed	2.622	0.109	-1.811	91.000	0.073	-0.506	0.279	-1.061	0.049
	Equal variances not assumed			-1.743	59.078	0.087	-0.506	0.290	-1.087	0.075
(6)	Equal variances assumed	0.037	0.847	-2.128	91.000	0.036	-2.247	1.056	-4.344	-0.150
	Equal variances not assumed			-2.077	61.526	0.042	-2.247	1.082	-4.410	-0.084
(7)	Equal variances assumed	0.296	0.587	-2.091	91.000	0.039	-2.324	1.111	-4.532	-0.117
	Equal variances not assumed			-2.009	58.791	0.049	-2.324	1.157	-4.639	-0.010
(8)	Equal variances assumed	0.281	0.597	-0.967	91.000	0.336	-0.216	0.223	-0.660	0.228
	Equal variances not assumed			-0.948	62.450	0.347	-0.216	0.228	-0.671	0.239
(9)	Equal variances assumed	3.889	0.052	-1.893	91.000	0.062	-0.571	0.302	-1.171	0.028
	Equal variances not assumed			-1.760	53.551	0.084	-0.571	0.325	-1.222	0.080
(7) + (8)	Equal variances assumed	0.120	0.730	-2.094	91.000	0.039	-2.603	1.243	-5.072	-0.134
	Equal variances not assumed			-2.027	60.060	0.047	-2.603	1.284	-5.171	-0.035

Appendix F.3
The productivity impact of ICT integration

F.3.1 ANOVA tests investigating productivity differences between three groups namely: 0) no ICT availability; 1) ICT availability and 2) ICT availability and PMS integration

Database									
Descriptive		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	26	66.147	19.403	3.805	58.310	73.984	37.911	100.000
	1	25	73.402	17.858	3.572	66.031	80.774	35.159	100.000
	2	42	77.136	18.394	2.838	71.404	82.868	40.734	100.000
	Total	93	73.060	18.905	1.960	69.167	76.953	35.159	100.000
ROOM4	0	26	77.777	17.847	3.500	70.569	84.985	44.967	100.000
	1	25	81.355	18.419	2.842	75.615	87.095	40.734	100.000
	2	42	90.539	13.008	2.602	85.169	95.908	58.056	100.000
	Total	93	82.823	17.500	1.815	79.219	86.427	40.734	100.000
FB4	0	26	72.804	21.178	4.153	64.250	81.358	25.766	100.000
	1	25	66.440	18.920	3.784	58.630	74.249	39.000	100.000
	2	42	79.135	17.915	2.764	73.552	84.717	45.717	100.000
	Total	93	73.952	19.654	2.038	69.904	78.000	25.766	100.000
TOT.OPER	0	26	88.018	13.514	2.650	82.559	93.476	53.521	100.000
	1	25	89.121	13.287	2.657	83.636	94.605	42.770	100.000
	2	42	92.927	12.435	1.919	89.052	96.802	52.725	100.000
	Total	93	90.532	13.021	1.350	87.850	93.213	42.770	100.000
MARK.EFF	0	26	41.123	26.860	5.268	30.274	51.972	12.477	100.000
	1	25	45.816	23.983	4.797	35.916	55.715	9.407	100.000
	2	42	48.269	26.724	4.124	39.942	56.597	5.994	100.000
	Total	93	45.612	25.948	2.691	40.268	50.956	5.994	100.000

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.565083	2	90	0.570316
ROOM4	4.350849	2	90	0.015715
FB4	0.520175	2	90	0.596193
TOT.OPER	0.362849	2	90	0.696704
MARK.EFF	0.447956	2	90	0.640349

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	1943.345	2	971.6727	2.826642	0.064479
	Within Groups	30937.97	90	343.7552		
	Total	32881.31	92			
ROOM4	Between Groups	2240.799	2	1120.399	3.888376	0.024005
	Within Groups	25932.66	90	288.1407		
	Total	28173.46	92			
FB4	Between Groups	2573.33	2	1286.665	3.513021	0.033958
	Within Groups	32963.05	90	366.2561		
	Total	35536.38	92			
TOT.OPER	Between Groups	455.1464	2	227.5732	1.3526	0.263772
	Within Groups	15142.39	90	168.2487		
	Total	15597.53	92			
MARK.EFF	Between Groups	821.4899	2	410.7449	0.604812	0.548382
	Within Groups	61121.56	90	679.1285		
	Total	61943.05	92			

Multiple Comparisons - Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO24	(J) XO24				Lower Bound	Upper Bound
ROOM4	0	1	-3.57819	4.235897	0.700909	-14.1216	6.965192
		2	-12.7617	4.754783	0.031274	-24.5966	-0.92677
	1	0	3.57819	4.235897	0.700909	-6.96519	14.12157
		2	-9.1835	4.287904	0.106783	-19.8563	1.489331
	2	0	12.7617	4.754783	0.031274	0.926771	24.59661
		1	9.1835	4.287904	0.106783	-1.48933	19.85633
FB4	0	1	6.364186	5.360692	0.496955	-6.97887	19.70724
		2	-6.33094	4.775684	0.418859	-18.2179	5.555998
	1	0	-6.36419	5.360692	0.496955	-19.7072	6.978872
		2	-12.6951	4.834317	0.036069	-24.728	-0.66225
	2	0	6.330942	4.775684	0.418859	-5.556	18.21788
		1	12.6951	4.834317	0.036069	0.662245	24.72801

* The mean difference is significant at the .05 level.

Ranks			
	Database	N	Mean Rank
ROOM4	0	26	38.32692
	1	25	58.78
	2	42	45.35714
	Total	93	

Test Statistics	
	ROOM4
Chi-Square	7.924967
df	2
Asymp. Sig.	0.019016
a	Kruskal Wallis Test

YIELD									
Descriptive		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	45	70.36271	19.15876	2.85602	64.60678	76.11864	35.15935	100
	1	16	74.62921	19.2603	4.815074	64.36612	84.89229	40.85955	100
	2	32	76.0684	18.41279	3.254953	69.42988	82.70692	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	45	81.0003	16.96418	2.52887	75.9037	86.0969	44.96655	100
	1	16	88.59321	15.89	3.972499	80.12603	97.06039	50.91847	100
	2	32	82.50242	18.86976	3.335734	75.69915	89.3057	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	45	70.47705	18.52331	2.761292	64.91204	76.04207	25.7662	100
	1	16	67.18295	17.44106	4.360266	57.88926	76.47664	43.10006	100
	2	32	82.22349	20.00861	3.537056	75.00962	89.43737	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	45	87.77016	13.5768	2.02391	83.69124	91.84909	42.76984	100
	1	16	88.54032	13.59087	3.397718	81.29826	95.78239	63.61259	100
	2	32	95.41043	10.69831	1.891212	91.55327	99.26758	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	45	41.66262	26.00193	3.876139	33.85077	49.47446	9.407036	100
	1	16	48.04131	26.18558	6.546395	34.088	61.99462	8.215705	91.43593
	2	32	49.951	25.7222	4.547086	40.67715	59.22484	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.03271	2	90	0.96783
ROOM4	1.20799	2	90	0.303595
FB4	0.57198	2	90	0.566445
TOT.OPER	2.173355	2	90	0.119732
MARK.EFF	0.095808	2	90	0.908731

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	656.4044	2	328.2022	0.916626	0.403566
	Within Groups	32224.91	90	358.0545		
	Total	32881.31	92			
ROOM4	Between Groups	685.5138	2	342.7569	1.122242	0.330061
	Within Groups	27487.95	90	305.4216		
	Total	28173.46	92			
FB4	Between Groups	3465.871	2	1732.935	4.863166	0.009873
	Within Groups	32070.51	90	356.339		
	Total	35536.38	92			
TOT.OPER	Between Groups	1168.286	2	584.143	3.643494	0.030092
	Within Groups	14429.25	90	160.325		
	Total	15597.53	92			
MARK.EFF	Between Groups	1398.778	2	699.3892	1.039653	0.357784
	Within Groups	60544.28	90	672.7142		
	Total	61943.05	92			

Multiple Comparisons-Scheffe

			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO2	(J) XO2				Lower Bound	Upper Bound
FB4	0	1	3.294106	5.494527	0.835807	-10.3821	16.97029
		2	-11.7464	4.365116	0.030734	-22.6115	-0.88143
	1	0	-3.29411	5.494527	0.835807	-16.9703	10.38208
		2	-15.0405	5.77986	0.038217	-29.4269	-0.65416
	2	0	11.74644	4.365116	0.030734	0.881426	22.61145
		1	15.04055	5.77986	0.038217	0.654156	29.42694
TOT.OPER	0	1	-0.77016	3.685524	0.978408	-9.94363	8.403316
		2	-7.64026	2.927957	0.037557	-14.9281	-0.35242
	1	0	0.770157	3.685524	0.978408	-8.40332	9.94363
		2	-6.8701	3.876914	0.213671	-16.52	2.779749
	2	0	7.640262	2.927957	0.037557	0.352415	14.92811
		1	6.870105	3.876914	0.213671	-2.77975	16.51996

* The mean difference is significant at the .05 level.

GDS

Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	46	71.43917	18.45116	2.720475	65.95985	76.91849	35.15935	100
	1	40	74.75202	19.12865	3.024504	68.63438	80.86966	39.49446	100
	2	7	74.04223	22.54205	8.520095	53.19431	94.89015	50.05984	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	46	81.80781	16.19516	2.387846	76.99844	86.61718	44.96655	100
	1	40	84.67696	17.96498	2.840512	78.93148	90.42244	40.73377	100
	2	7	78.90641	24.12318	9.117706	56.59619	101.2166	50.05986	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	46	73.17142	20.57287	3.033304	67.06204	79.28081	25.7662	100
	1	40	73.82658	19.32678	3.055833	67.64558	80.00759	43.10006	100
	2	7	79.79966	16.60808	6.277265	64.43974	95.15957	54.44555	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	46	90.90747	12.60683	1.858776	87.1637	94.65124	42.76984	100
	1	40	89.64016	14.09471	2.22857	85.13245	94.14786	52.72462	100
	2	7	93.15518	10.09405	3.815191	83.81974	102.4906	73.26363	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	46	40.08453	24.89728	3.670904	32.69095	47.47811	8.215705	100
	1	40	52.097	27.33821	4.32255	43.35382	60.84019	5.994269	100
	2	7	44.87744	17.36641	6.563886	28.81619	60.93869	16.66153	69.32027
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
ROOM3	0.812454	2	90	0.446995
ROOM4	2.913233	2	90	0.059438
FB4	0.624388	2	90	0.537893
TOT.OPER	1.257401	2	90	0.28934
MARK.EFF	1.412475	2	90	0.248886

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	242.1164	2	121.0582	0.333808	0.717074
	Within Groups	32639.2	90	362.6577		
	Total	32881.31	92			
ROOM4	Between Groups	292.2726	2	146.1363	0.471726	0.625459
	Within Groups	27881.19	90	309.791		
	Total	28173.46	92			
FB4	Between Groups	268.0228	2	134.0114	0.341979	0.711282
	Within Groups	35268.35	90	391.8706		
	Total	35536.38	92			
TOT.OPER	Between Groups	86.46782	2	43.23391	0.250857	0.778676
	Within Groups	15511.06	90	172.3452		
	Total	15597.53	92			
MARK.EFF	Between Groups	3091.421	2	1545.711	2.363808	0.099877
	Within Groups	58851.63	90	653.907		
	Total	61943.05	92			

CRS

Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	28	68.81443	19.50899	3.686852	61.24964	76.37923	35.15935	100
	1	33	73.71002	17.42484	3.033275	67.53144	79.8886	39.49446	100
	2	32	76.10448	19.73523	3.488728	68.98917	83.21979	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	28	78.13327	17.80618	3.365053	71.22875	85.03779	44.96655	100
	1	33	85.35754	16.14858	2.811107	79.63151	91.08358	53.01056	100
	2	32	84.31412	18.28892	3.233054	77.72026	90.90798	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	28	77.54389	21.32851	4.030709	69.27356	85.81422	25.7662	100
	1	33	70.93504	18.7917	3.271214	64.27179	77.59829	43.10006	100
	2	32	73.92066	19.08572	3.37391	67.03953	80.80179	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	28	88.91588	13.69041	2.587244	83.60729	94.22446	42.76984	100
	1	33	90.26449	13.03282	2.268723	85.64325	94.88573	53.52083	100
	2	32	92.22074	12.61707	2.230404	87.6718	96.76967	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	28	38.61729	25.67311	4.851762	28.6623	48.57229	8.215705	100
	1	33	53.43004	27.41107	4.771656	43.71049	63.14958	13.42196	100
	2	32	43.66985	23.13755	4.09018	35.32787	52.01182	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.536599	2	90	0.586593
ROOM4	0.53971	2	90	0.584792
FB4	0.520927	2	90	0.59575
TOT.OPER	0.159109	2	90	0.853142
MARK.EFF	0.970769	2	90	0.382722

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	815.2417	2	407.6209	1.144072	0.323108
	Within Groups	32066.07	90	356.2897		
	Total	32881.31	92			
ROOM4	Between Groups	898.9589	2	449.4794	1.483186	0.232407
	Within Groups	27274.5	90	303.05		
	Total	28173.46	92			
FB4	Between Groups	661.6464	2	330.8232	0.853744	0.429237
	Within Groups	34874.73	90	387.497		
	Total	35536.38	92			
TOT.OPER	Between Groups	166.7519	2	83.37594	0.48629	0.61651
	Within Groups	15430.78	90	171.4531		
	Total	15597.53	92			
MARK.EFF	Between Groups	3507.646	2	1753.823	2.701171	0.07257
	Within Groups	58435.41	90	649.2823		
	Total	61943.05	92			

PBRS

Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	23	61.36355	16.41339	3.422428	54.26586	68.46123	35.15935	99.93937
	1	17	78.44074	18.73657	4.544285	68.80728	88.07419	39.49446	100
	2	53	76.40989	18.13628	2.491209	71.41091	81.40887	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	23	78.92959	18.93571	3.948369	70.74118	87.11801	44.96655	100
	1	17	92.62527	11.0451	2.67883	86.94641	98.30414	62.16626	100
	2	53	81.36928	17.67175	2.427401	76.49835	86.24022	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	23	72.60205	21.28355	4.437926	63.39836	81.80575	25.7662	100
	1	17	70.2218	18.21648	4.418145	60.85575	79.58785	43.41038	100
	2	53	75.7345	19.52036	2.681328	70.35403	81.11498	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	23	87.53003	14.84365	3.095114	81.11116	93.94891	42.76984	100
	1	17	88.66621	13.15662	3.19095	81.9017	95.43072	53.52083	100
	2	53	92.43245	12.02783	1.652149	89.11717	95.74773	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	23	39.04958	25.22758	5.260313	28.14036	49.95881	9.407036	100
	1	17	48.63662	28.78147	6.980531	33.83855	63.43468	12.47675	100
	2	53	47.48958	25.32662	3.478878	40.5087	54.47046	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	1.068052	2	90	0.347992
ROOM4	7.330841	2	90	0.001123
FB4	0.215197	2	90	0.806796
TOT.OPER	0.403501	2	90	0.66918
MARK.EFF	0.912941	2	90	0.405026

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	4233.504	2	2116.752	6.649991	0.002025
	Within Groups	28647.81	90	318.309		
	Total	32881.31	92			
ROOM4	Between Groups	2094.09	2	1047.045	3.613356	0.030943
	Within Groups	26079.37	90	289.7708		
	Total	28173.46	92			
FB4	Between Groups	446.857	2	223.4285	0.573065	0.565839
	Within Groups	35089.52	90	389.8835		
	Total	35536.38	92			
TOT.OPER	Between Groups	457.8719	2	228.9359	1.360944	0.261644
	Within Groups	15139.66	90	168.2184		
	Total	15597.53	92			
MARK.EFF	Between Groups	1332.865	2	666.4325	0.989585	0.375739
	Within Groups	60610.19	90	673.4465		
	Total	61943.05	92			

Multiple Comparisons-Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO3	(J) XO3				Lower Bound	Upper Bound
ROOM3	0	1	-17.0772	5.706451	0.013998	-31.2809	-2.87352
		2	-15.0463	4.454812	0.004653	-26.1346	-3.95807
	1	0	17.07719	5.706451	0.013998	2.873519	31.28086
		2	2.030848	4.972915	0.920065	-10.347	14.40871
	2	0	15.04634	4.454812	0.004653	3.958068	26.13462
		1	-2.03085	4.972915	0.920065	-14.4087	10.34701
ROOM4	0	1	-13.6957	5.444637	0.047007	-27.2477	-0.14368
		2	-2.43969	4.250424	0.848377	-13.0192	8.13985
	1	0	13.69568	5.444637	0.047007	0.143678	27.24768
		2	11.25599	4.744756	0.065256	-0.55397	23.06595
	2	0	2.43969	4.250424	0.848377	-8.13985	13.01923
		1	-11.256	4.744756	0.065256	-23.066	0.553971

* The mean difference is significant at the .05 level.

Ranks			
	PBRS	N	Mean Rank
ROOM4	0	23	41.32609
	1	17	61.76471
	2	53	44.72641
	Total	93	

Test Statistics	
	ROOM4
Chi-Square	6.75448
df	2
Asymp. Sig.	0.034142
a	Kruskal Wallis Test

Marketing & sales									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	52	71.07258	18.1595	2.518269	66.01695	76.12822	35.15935	100
	1	15	74.41347	21.59748	5.576445	62.45319	86.37376	40.85955	100
	2	26	76.25391	19.01028	3.728222	68.57549	83.93233	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	52	83.1979	17.0691	2.367058	78.44583	87.94996	44.96655	100
	1	15	87.04659	15.35189	3.963841	78.54499	95.54818	62.05953	100
	2	26	79.63819	19.46922	3.818228	71.7744	87.50198	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	52	71.68189	21.391	2.966399	65.72659	77.63718	25.7662	100
	1	15	70.96381	13.19095	3.405889	63.65891	78.26872	46.82835	96.33988
	2	26	80.21658	18.26663	3.582381	72.83853	87.59464	45.71711	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	52	88.3116	14.16883	1.964863	84.36698	92.25623	42.76984	100
	1	15	93.28298	8.421645	2.174459	88.61923	97.94673	75.95174	100
	2	26	93.38416	12.30392	2.412996	88.4145	98.35382	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	52	45.12178	25.04476	3.473084	38.14927	52.09428	9.407036	100
	1	15	49.51993	32.73896	8.453164	31.3897	67.65016	9.704776	100
	2	26	44.33767	24.21921	4.749778	34.55531	54.12002	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.580708	2	90	0.561584
ROOM4	1.168554	2	90	0.315487
FB4	5.780756	2	90	0.004346
TOT.OPER	1.766996	2	90	0.17672
MARK.EFF	1.972555	2	90	0.145069

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	498.097	2	249.0485	0.69216	0.503138
	Within Groups	32383.22	90	359.8135		
	Total	32881.31	92			
ROOM4	Between Groups	538.6071	2	269.3036	0.877056	0.419531
	Within Groups	27634.85	90	307.0539		
	Total	28173.46	92			
FB4	Between Groups	1422.287	2	711.1437	1.876144	0.159121
	Within Groups	34114.09	90	379.0454		
	Total	35536.38	92			
TOT.OPER	Between Groups	581.3911	2	290.6956	1.742299	0.180972
	Within Groups	15016.14	90	166.846		
	Total	15597.53	92			
MARK.EFF	Between Groups	283.7975	2	141.8988	0.20712	0.813308
	Within Groups	61659.26	90	685.1029		
	Total	61943.05	92			

Ranks			
	Marketing & sales	N	Mean Rank
FB4	0	52	44.26923
	1	15	42.66667
	2	26	54.96154
	Total	93	

Test Statistics	
	FB4
Chi-Square	3.204323
df	2
Asymp. Sig.	0.050015
a	Kruskal Wallis Test

				Telephone system					
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	18	66.01426	19.76526	4.658717	56.18523	75.8433	37.91055	100
	1	29	70.00389	19.28251	3.580673	62.66922	77.33857	35.15935	100
	2	46	77.74366	17.42008	2.568451	72.57054	82.91679	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	18	76.69693	18.44761	4.348143	67.52315	85.87072	44.96655	100
	1	29	85.29773	17.88835	3.321784	78.49337	92.1021	50.91847	100
	2	46	83.66094	16.69523	2.461578	78.70307	88.61881	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	18	74.33067	20.49239	4.830102	64.14004	84.52129	25.7662	100
	1	29	68.46957	17.97994	3.338791	61.63037	75.30878	38.99998	100
	2	46	77.26036	19.98217	2.946211	71.32639	83.19434	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	18	86.40177	13.9369	3.284959	79.47111	93.33243	53.52083	100
	1	29	87.37536	14.75985	2.740835	81.76101	92.9897	42.76984	100
	2	46	94.13737	10.54266	1.554431	91.00659	97.26815	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	18	37.33215	25.91631	6.108532	24.44427	50.22002	8.215705	100
	1	29	46.10169	28.08415	5.215097	35.41905	56.78434	9.407036	100
	2	46	48.54311	24.4061	3.598484	41.29539	55.79082	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.03418	2	90	0.96641
ROOM4	0.388378	2	90	0.679287
FB4	0.659722	2	90	0.519477
TOT.OPER	2.577003	2	90	0.081601
MARK.EFF	0.381118	2	90	0.684195

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	2173.505	2	1086.752	3.185109	0.046077
	Within Groups	30707.81	90	341.1979		
	Total	32881.31	92			
ROOM4	Between Groups	885.4198	2	442.7099	1.460123	0.237655
	Within Groups	27288.04	90	303.2004		
	Total	28173.46	92			
FB4	Between Groups	1377.716	2	688.8579	1.814978	0.168751
	Within Groups	34158.66	90	379.5407		
	Total	35536.38	92			
TOT.OPER	Between Groups	1193.966	2	596.9829	3.730219	0.027774
	Within Groups	14403.57	90	160.0396		
	Total	15597.53	92			
MARK.EFF	Between Groups	1636.166	2	818.0828	1.22088	0.299808
	Within Groups	60306.89	90	670.0765		
	Total	61943.05	92			

Multiple Comparisons- Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO20	(J) XO20				Lower Bound	Upper Bound
ROOM3	0	1	-3.98963	5.542642	0.77235	-17.7856	9.806311
		2	-11.7294	5.135444	0.044218	-24.5118	1.053004
	1	0	3.989631	5.542642	0.77235	-9.80631	17.78557
		2	-7.73977	4.379816	0.215473	-18.6414	3.161837
	2	0	11.7294	5.135444	0.044218	-1.053	24.5118
		1	7.739767	4.379816	0.215473	-3.16184	18.64137
TOT.OPER	0	1	-0.97359	3.796011	0.967656	-10.4221	8.474891
		2	-7.7356	3.517131	0.049805	-16.4899	1.018732
	1	0	0.97359	3.796011	0.967656	-8.47489	10.42207
		2	-6.76201	2.999622	0.084436	-14.2282	0.704212
	2	0	7.735602	3.517131	0.049805	-1.01873	16.48994
		1	6.762012	2.999622	0.084436	-0.70421	14.22824

Check in/out kiosks									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	82	71.999	17.94002	1.981144	68.05715	75.94086	35.15935	100
	1	4	96.63218	6.735648	3.367824	85.91426	107.3501	86.5287	100
	2	7	72.01872	26.93614	10.1809	47.10695	96.93049	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	82	82.88302	16.51287	1.823541	79.25475	86.5113	44.96655	100
	1	4	99.31896	1.362086	0.681043	97.15157	101.4863	97.27583	100
	2	7	72.6998	26.69307	10.08903	48.01283	97.38677	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	82	75.28035	19.7515	2.181188	70.94047	79.62023	25.7662	100
	1	4	56.53925	10.99541	5.497707	39.04309	74.03541	43.41038	67.42329
	2	7	68.343	18.23952	6.89389	51.47426	85.21174	45.71711	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	82	91.19544	12.18955	1.34611	88.5171	93.87377	42.76984	100
	1	4	92.01332	15.97337	7.986684	66.59612	117.4305	68.05326	100
	2	7	81.90818	19.28399	7.288664	64.07346	99.7429	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	82	45.10859	25.34619	2.799018	39.53943	50.67776	5.994269	100
	1	4	71.96356	32.13736	16.06868	20.82585	123.1013	28.15085	100
	2	7	36.45024	23.88127	9.02627	14.36375	58.53673	9.808744	79.4699
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	5.303852	2	90	0.006645
ROOM4	12.19785	2	90	2.05E-05
FB4	1.567156	2	90	0.214277
TOT.OPER	2.382038	2	90	0.098162
MARK.EFF	0.251664	2	90	0.778052

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	2322.488	2	1161.244	3.420026	0.05702
	Within Groups	30558.82	90	339.5425		
	Total	32881.31	92			
ROOM4	Between Groups	1806.116	2	903.058	3.08242	0.05072
	Within Groups	26367.34	90	292.9705		
	Total	28173.46	92			
FB4	Between Groups	1577.732	2	788.8658	2.090717	0.129561
	Within Groups	33958.64	90	377.3183		
	Total	35536.38	92			
TOT.OPER	Between Groups	565.461	2	282.7305	1.692764	0.189816
	Within Groups	15032.07	90	167.023		
	Total	15597.53	92			
MARK.EFF	Between Groups	3385.964	2	1692.982	2.602049	0.079691
	Within Groups	58557.09	90	650.6343		
	Total	61943.05	92			

Ranks			
	Check in out kiosks	N	Mean Rank
ROOM3	0	82	45.59146
	1	4	80.375
	2	7	44.42857
	Total	93	
ROOM4	0	82	46.60976
	1	4	72.125
	2	7	37.21429
	Total	93	

Test Statistics		
	ROOM3	ROOM4
Chi-Square	6.435577	4.59023
df	2	2
Asymp. Sig.	0.050044	0.10075
a	Kruskal Wallis Test	

HRM									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	75	71.7017	18.24945	2.107265	67.50288	75.90051	35.15935	100
	1	17	77.4677	20.9788	5.088105	66.6814	88.25401	51.38844	100
	2	1	100	.	.	.	.	100	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	75	82.99564	17.04502	1.96819	79.07393	86.91734	40.73377	100
	1	17	81.05351	19.88013	4.821641	70.83209	91.27493	51.38844	100
	2	1	100	.	.	.	.	100	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	75	72.30753	19.8253	2.289229	67.74614	76.86892	25.7662	100
	1	17	79.6754	17.70068	4.293045	70.57455	88.77625	51.34196	100
	2	1	100	.	.	.	.	100	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	75	89.66207	13.35014	1.541541	86.59048	92.73365	42.76984	100
	1	17	93.81066	11.4008	2.7651	87.94891	99.67241	63.61259	100
	2	1	100	.	.	.	.	100	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	75	44.84451	26.5014	3.060118	38.74709	50.94192	5.994269	100
	1	17	47.26508	23.73404	5.756349	35.06217	59.46799	11.08281	79.4699
	2	1	75.0663	.	.	.	.	75.0663	75.0663
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

F&A									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	20	65.55449	18.57351	4.153163	56.86182	74.24716	35.15935	100
	1	21	74.10235	22.57262	4.92575	63.82741	84.37728	39.49446	100
	2	52	75.52575	16.96056	2.352007	70.8039	80.2476	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	20	77.50525	18.25933	4.082911	68.95962	86.05088	44.96655	100
	1	21	86.64089	16.37196	3.572656	79.18846	94.09332	51.38844	100
	2	52	83.32728	17.48561	2.424818	78.45926	88.19531	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	20	68.14697	22.76946	5.091406	57.49053	78.8034	25.7662	100
	1	21	67.9516	17.31882	3.779276	60.06817	75.83503	43.41038	100
	2	52	78.60814	18.32689	2.541482	73.5059	83.71038	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	20	86.33867	15.96529	3.569947	78.86669	93.81066	42.76984	100
	1	21	88.72819	12.70897	2.773324	82.94313	94.51324	53.52083	100
	2	52	92.87252	11.56346	1.603563	89.65323	96.0918	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	20	45.36747	27.10391	6.060618	32.68245	58.05249	9.407036	100
	1	21	44.29497	28.77902	6.280097	31.19492	57.39503	9.704776	100
	2	52	46.23782	24.79825	3.438898	39.33395	53.1417	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	2.053092	2	90	0.134306
ROOM4	0.246994	2	90	0.781673
FB4	1.154487	2	90	0.319843
TOT.OPER	1.661918	2	90	0.195545
MARK.EFF	1.024347	2	90	0.363178

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	1465.626	2	732.8128	2.09937	0.128494
	Within Groups	31415.69	90	349.0632		
	Total	32881.31	92			
ROOM4	Between Groups	884.8944	2	442.4472	1.459228	0.237861
	Within Groups	27288.57	90	303.2063		
	Total	28173.46	92			
FB4	Between Groups	2557.411	2	1278.705	3.489603	0.034704
	Within Groups	32978.97	90	366.4329		
	Total	35536.38	92			
TOT.OPER	Between Groups	704.8654	2	352.4327	2.129837	0.124809
	Within Groups	14892.67	90	165.4741		
	Total	15597.53	92			
MARK.EFF	Between Groups	57.98785	2	28.99392	0.042166	0.958729
	Within Groups	61885.07	90	687.6119		
	Total	61943.05	92			

Multiple Comparisons-Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO6	(J) XO6				Lower Bound	Upper Bound
FB4	0	1	0.195367	5.980872	0.999467	-14.6914	15.08209
		2	-10.4612	5.036709	0.121622	-0.04755	2.075472
	1	0	-0.19537	5.980872	0.999467	-15.0821	14.69135
		2	-10.6565	4.949341	0.104325	-22.9757	1.662641
	2	0	10.46117	5.036709	0.121622	-0.04755	22.99782
		1	10.65654	4.949341	0.104325	-1.66264	22.97572

* The mean difference is significant at the .05 level.

Management & executive systems									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	85	71.8925	18.44289	2.000412	67.91446	75.87054	35.15935	100
	1	6	86.22317	21.8341	8.913736	63.30968	109.1367	51.38844	100
	2	2	83.18832	23.77531	16.81168	-130.424	296.801	66.37664	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	85	82.20637	17.31996	1.878613	78.47054	85.9422	40.73377	100
	1	6	91.44405	19.65339	8.023462	70.81908	112.069	51.38844	100
	2	2	83.18832	23.7753	16.81168	-130.424	296.801	66.37664	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	85	73.92484	19.84836	2.152857	69.64365	78.20604	25.7662	100
	1	6	76.03335	21.49254	8.774294	53.47831	98.58839	43.41038	100
	2	2	68.8673	7.519612	5.317169	1.306265	136.4283	63.55013	74.18447
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	85	89.76105	13.32689	1.445504	86.88651	92.63559	42.76984	100
	1	6	98.29118	4.185728	1.708816	93.89853	102.6838	89.7471	100
	2	2	100	1.95E-08	1.38E-08	100	100	100	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	85	44.11714	25.46719	2.762305	38.624	49.61029	5.994269	100
	1	6	56.95464	26.53785	10.83403	29.10487	84.80441	16.66153	91.43593
	2	2	75.11282	35.19579	24.88718	-241.109	391.3345	50.22563	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Conference & Banqueting systems									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	60	69.13022	17.75406	2.292039	64.54386	73.71658	35.15935	100
	1	19	77.85232	20.86931	4.787748	67.79364	87.91101	40.73374	100
	2	14	83.39791	16.60734	4.438498	73.80912	92.9867	51.23418	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	60	81.17183	16.98155	2.192309	76.78503	85.55863	44.96655	100
	1	14	90.56611	13.34074	3.565464	82.86339	98.26882	62.16626	100
	2	19	82.33405	20.86766	4.78737	72.27616	92.39194	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	60	73.82211	19.47052	2.513633	68.79234	78.85187	25.7662	100
	1	14	66.47812	16.42635	4.390127	56.99382	75.96241	43.41038	100
	2	19	79.86981	21.361	4.900549	69.57414	90.16549	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	60	88.41866	13.40037	1.729981	84.95698	91.88035	42.76984	100
	1	14	93.46553	8.964178	2.395777	88.28977	98.6413	75.95174	100
	2	19	95.04205	13.2986	3.050908	88.63233	101.4518	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	60	44.57866	25.76356	3.326062	37.92323	51.23409	5.994269	100
	1	14	47.12634	28.40402	7.591292	30.72635	63.52633	12.47675	91.43593
	2	19	47.75907	25.93704	5.950366	35.25782	60.26032	9.808744	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	1.342	2	90	0.266501
ROOM4	3.610161	2	90	0.031035
FB4	2.302172	2	90	0.105905
TOT.OPER	1.301294	2	90	0.277251
MARK.EFF	0.425025	2	90	0.655059

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	2859.164	2	1429.582	4.285583	0.016679
	Within Groups	30022.15	90	333.5794		
	Total	32881.31	92			
ROOM4	Between Groups	1007.503	2	503.7517	1.668914	0.19423
	Within Groups	27165.96	90	301.844		
	Total	28173.46	92			
FB4	Between Groups	1448.428	2	724.2138	1.91209	0.153726
	Within Groups	34087.95	90	378.755		
	Total	35536.38	92			
TOT.OPER	Between Groups	774.9203	2	387.4601	2.352582	0.100948
	Within Groups	14822.61	90	164.6957		
	Total	15597.53	92			
MARK.EFF	Between Groups	183.761	2	91.88048	0.133895	0.874856
	Within Groups	61759.29	90	686.2144		
	Total	61943.05	92			

Multiple Comparisons- Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO7	(J) XO7				Lower Bound	Upper Bound
ROOM3	0	1	-8.7221	4.807959	0.198672	-20.6894	3.245175
		2	-14.2677	5.420956	0.035552	-27.7607	-0.77463
	1	0	8.722101	4.807959	0.198672	-3.24517	20.68938
		2	-5.54559	6.433033	0.690708	-21.5578	10.46658
	2	0	14.26769	5.420956	0.035552	0.774633	27.76075
		1	5.545591	6.433033	0.690708	-10.4666	21.55777

* The mean difference is significant at the .05 level.

Ranks			
	Conf & banq syst	N	Mean Rank
ROOM4	0	60	44.03333
	1	14	57.89286
	2	19	48.34211
	Total	93	

Test Statistics	
	ROOM4
Chi-Square	3.181595
df	2
Asymp. Sig.	0.203763
a	Kruskal Wallis Test

F&B systems									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	52	72.10594	20.22775	2.805084	66.47449	77.73738	35.15935	100
	1	21	73.43544	16.07046	3.506861	66.12026	80.75062	51.23418	100
	2	20	75.14626	18.79463	4.202607	66.35011	83.94242	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	52	84.17417	16.38665	2.27242	79.61209	88.73624	44.96655	100
	1	21	83.3051	18.2033	3.972285	75.01906	91.59114	53.01056	100
	2	20	78.80593	19.7738	4.421556	69.5515	88.06035	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	52	70.84299	19.25578	2.670296	65.48215	76.20383	25.7662	100
	1	21	69.02044	17.61203	3.84326	61.00354	77.03734	41.74108	100
	2	20	87.21408	17.60931	3.93756	78.97267	95.45549	45.71711	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	52	87.94415	13.67906	1.896944	84.13588	91.75242	42.76984	100
	1	21	92.50039	11.44123	2.496682	87.2924	97.70838	63.61259	100
	2	20	95.19161	11.63637	2.601971	89.74562	100.6376	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	52	40.99656	23.80553	3.301233	34.36906	47.62407	8.215705	100
	1	21	52.00422	29.29347	5.737705	46.03558	69.97286	14.19837	100
	2	20	44.60004	25.96723	6.253662	31.51097	57.6891	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	1.12484	2	90	0.329226
ROOM4	1.703778	2	90	0.187812
FB4	0.504345	2	90	0.605597
TOT.OPER	1.298756	2	90	0.277935
MARK.EFF	0.259701	2	90	0.771858

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	137.3423	2	68.67116	0.188749	0.828321
	Within Groups	32743.97	90	363.8219		
	Total	32881.31	92			
ROOM4	Between Groups	422.5521	2	211.2761	0.685197	0.5066
	Within Groups	27750.91	90	308.3434		
	Total	28173.46	92			
FB4	Between Groups	4531.008	2	2265.504	6.576131	0.00216
	Within Groups	31005.37	90	344.5041		
	Total	35536.38	92			
TOT.OPER	Between Groups	863.8474	2	431.9237	2.638385	0.077001
	Within Groups	14733.68	90	163.7076		
	Total	15597.53	92			
MARK.EFF	Between Groups	4353.107	2	2176.553	3.401458	0.057665
	Within Groups	57589.95	90	639.8883		
	Total	61943.05	92			

Multiple Comparisons-Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO8	(J) XO8				Lower Bound	Upper Bound
FB4	0	1	1.822551	4.798962	0.930476	-10.1223	13.76743
		2	-16.3711	4.883675	0.005019	-28.5268	-4.21535
	1	0	-1.82255	4.798962	0.930476	-13.7674	10.12233
		2	-18.1936	5.799152	0.009369	-32.628	-3.75923
	2	0	16.37109	4.883675	0.005019	4.215348	28.52682
		1	18.19364	5.799152	0.009369	3.759227	32.62805

* The mean difference is significant at the .05 level.

stock & inventory systems									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	45	67.61162	18.09799	2.697888	62.17438	73.04886	35.15935	100
	1	25	75.21272	17.29144	3.458287	68.07517	82.35027	40.85955	100
	2	23	81.37988	19.36502	4.037886	73.00582	89.75394	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	45	78.35766	17.76593	2.648389	73.02018	83.69513	44.96655	100
	1	25	85.6625	13.64699	2.729397	83.0293	94.2957	63.1926	100
	2	23	85.21415	18.99136	3.959972	77.00167	93.42662	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	45	72.93113	19.48036	2.903961	67.07858	78.78368	25.7662	100
	1	25	67.43428	19.7746	3.95492	59.27173	75.59683	41.74108	100
	2	23	83.03429	17.12001	3.569769	75.63104	90.43754	45.71711	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	45	88.12494	14.22998	2.12128	83.84979	92.4001	42.76984	100
	1	25	90.68139	11.46751	2.293502	85.94784	95.41495	63.61259	100
	2	23	95.07734	11.27207	2.35039	90.20293	99.95175	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	45	41.11493	23.58015	3.515121	34.03067	48.19919	9.407036	100
	1	25	45.88277	26.79206	5.358411	34.82356	56.94199	5.994269	100
	2	23	54.11606	28.34467	5.910271	41.85891	66.37322	9.808744	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.29606	2	90	0.744464
ROOM4	1.823018	2	90	0.167452
FB4	0.583441	2	90	0.560071
TOT.OPER	2.036307	2	90	0.13648
MARK.EFF	0.93884	2	90	0.394877

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	3043.743	2	1521.871	4.590468	0.012637
	Within Groups	29837.57	90	331.5286		
	Total	32881.31	92			
ROOM4	Between Groups	1881.267	2	940.6337	3.219855	0.054606
	Within Groups	26292.19	90	292.1355		
	Total	28173.46	92			
FB4	Between Groups	3006.139	2	1503.07	4.158478	0.018734
	Within Groups	32530.24	90	361.4471		
	Total	35536.38	92			
TOT.OPER	Between Groups	736.467	2	368.2335	2.230057	0.113431
	Within Groups	14861.06	90	165.1229		
	Total	15597.53	92			
MARK.EFF	Between Groups	2575.236	2	1287.618	1.951994	0.147956
	Within Groups	59367.82	90	659.6424		
	Total	61943.05	92			

Multiple Comparisons-Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO9	(J) XO9				Lower Bound	Upper Bound
ROOM3	0	1	-7.6011	4.541855	0.251814	-18.906	3.703826
		2	-13.7683	4.667075	0.015705	-25.3849	-2.15165
	1	0	7.601101	4.541855	0.251814	-3.70383	18.90603
		2	-6.16716	5.260744	0.505631	-19.2614	6.927123
	2	0	13.76826	4.667075	0.015705	2.151653	25.38487
		1	6.167159	5.260744	0.505631	-6.92712	19.26144
FB4	0	1	5.496846	4.742367	0.513357	-6.30717	17.30086
		2	-10.1032	4.873115	0.122526	-22.2326	2.026287
	1	0	-5.49685	4.742367	0.513357	-17.3009	6.307166
		2	-15.6	5.492993	0.021022	-29.2724	-1.92765
	2	0	10.10316	4.873115	0.122526	-2.02629	22.23262
		1	15.60001	5.492993	0.021022	1.927648	29.27237

* The mean difference is significant at the .05 level.

EPOS									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	34	65.50812	17.9459	3.077696	59.2465	71.76974	37.91055	100
	1	18	75.21435	19.62203	4.624956	65.45654	84.97215	35.15935	100
	2	41	78.37668	17.69643	2.763717	72.79099	83.96236	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	34	77.50001	18.14007	3.110997	71.17064	83.82939	44.96655	100
	1	18	85.45347	15.9326	3.75535	77.53037	93.37656	55.39137	100
	2	41	86.0834	16.93757	2.645203	80.73724	91.42956	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	34	71.08843	19.59137	3.359892	64.25268	77.92418	25.7662	100
	1	18	64.95152	15.88497	3.744124	57.05211	72.85093	38.99998	98.77366
	2	41	80.27835	19.49533	3.044659	74.12487	86.43184	43.10006	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	34	86.52432	13.39424	2.297093	81.85085	91.19779	53.52083	100
	1	18	91.50332	15.18674	3.579549	83.95113	99.05551	42.76984	100
	2	41	93.42804	11.01064	1.719574	89.95265	96.90343	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	34	46.46994	27.864	4.778637	36.74773	56.19215	9.704776	100
	1	18	42.1129	25.44709	5.997937	29.45836	54.76744	8.215705	91.43593
	2	41	46.4366	25.02002	3.90747	38.53931	54.33389	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.274846	2	90	0.760324
ROOM4	0.770767	2	90	0.465687
FB4	1.259164	2	90	0.288844
TOT.OPER	1.569323	2	90	0.213829
MARK.EFF	0.350467	2	90	0.705316

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	3181.539	2	1590.77	4.820551	0.010261
	Within Groups	29699.77	90	329.9975		
	Total	32881.31	92			
ROOM4	Between Groups	1523.749	2	761.8745	2.572962	0.081913
	Within Groups	26649.71	90	296.1079		
	Total	28173.46	92			
FB4	Between Groups	3377.889	2	1688.944	4.726746	0.011169
	Within Groups	32158.49	90	357.3165		
	Total	35536.38	92			
TOT.OPER	Between Groups	906.9419	2	453.4709	2.778131	0.067492
	Within Groups	14690.59	90	163.2288		
	Total	15597.53	92			
MARK.EFF	Between Groups	273.2914	2	136.6457	0.199419	0.819568
	Within Groups	61669.76	90	685.2196		
	Total	61943.05	92			

Multiple Comparisons- Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO10	(J) XO10				Lower Bound	Upper Bound
ROOM3	0	1	-9.70622	5.295187	0.192166	-22.8862	3.473789
		2	-12.8686	4.213612	0.011826	-23.3565	-2.38064
	1	0	9.706223	5.295187	0.192166	-3.47379	22.88624
		2	-3.16233	5.136333	0.827677	-15.9469	9.622286
	2	0	12.86855	4.213612	0.011826	2.380639	23.35647
		1	3.16233	5.136333	0.827677	-9.62229	15.94695
FB4	0	1	6.136908	5.510012	0.540095	-7.57782	19.85163
		2	-9.18992	4.384558	0.117111	-20.1033	1.723483
	1	0	-6.13691	5.510012	0.540095	-19.8516	7.577815
		2	-15.3268	5.344713	0.019553	-28.6301	-2.02355
	2	0	9.189924	4.384558	0.117111	-1.72348	20.10333
		1	15.32683	5.344713	0.019553	2.023546	28.63012

* The mean difference is significant at the .05 level.

Automated mini bars

Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	86	72.73571	18.88313	2.03622	68.68716	76.78426	35.15935	100
	1	4	77.71173	23.00197	11.50098	41.11046	114.313	50.05984	100
	2	3	76.15334	20.74944	11.97969	24.60887	127.6978	62.21958	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	86	82.81674	17.387	1.874889	79.08896	86.54452	40.73377	100
	1	4	85.7333	24.01841	12.00921	47.51465	123.952	50.05986	100
	2	3	79.13654	18.33019	10.58294	33.60182	124.6713	65.61727	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	86	72.51907	19.24845	2.075614	68.3922	76.64595	25.7662	100
	1	4	87.99311	22.39541	11.1977	52.35702	123.6292	54.44555	100
	2	3	96.31119	6.082197	3.511558	81.20218	111.4202	89.29111	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	86	90.07177	13.17005	1.420163	87.24811	92.89544	42.76984	100
	1	4	93.31591	13.36818	6.684092	72.04414	114.5877	73.26363	100
	2	3	100	3.66E-09	2.12E-09	100	100	100	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	86	45.09308	25.68949	2.770169	39.58525	50.60092	5.994269	100
	1	4	52.21278	31.87199	15.93599	1.497327	102.9282	35.02152	100
	2	3	51.68474	35.29699	20.37873	-35.9979	139.3673	11.08281	75.0663
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
ROOM3	0.139748	2	90	0.869766
ROOM4	0.232507	2	90	0.793018
FB4	2.043942	2	90	0.135487
TOT.OPER	2.667813	2	90	0.074891
MARK.EFF	0.283473	2	90	0.753833

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	124.3045	2	62.15227	0.170764	0.843293
	Within Groups	32757.01	90	363.9668		
	Total	32881.31	92			
ROOM4	Between Groups	74.65278	2	37.32639	0.119556	0.887455
	Within Groups	28098.81	90	312.209		
	Total	28173.46	92			
FB4	Between Groups	2464.993	2	1232.497	3.354099	0.039361
	Within Groups	33071.38	90	367.4598		
	Total	35536.38	92			
TOT.OPER	Between Groups	318.1451	2	159.0726	0.936983	0.395596
	Within Groups	15279.39	90	169.771		
	Total	15597.53	92			
MARK.EFF	Between Groups	308.0729	2	154.0365	0.224926	0.799023
	Within Groups	61634.98	90	684.8331		
	Total	61943.05	92			

Multiple Comparisons-scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO11	(J) XO11				Lower Bound	Upper Bound
FB4	0	1	-15.474	9.804986	0.292759	-39.8792	8.931114
		2	-23.7921	11.25875	0.041131	-51.8158	4.231528
	1	0	15.47404	9.804986	0.292759	-8.93111	39.87919
		2	-8.31808	14.64075	0.851202	-44.7597	28.12356
	2	0	23.79212	11.25875	0.041131	-4.23153	51.81576
		1	8.31808	14.64075	0.851202	-28.1236	44.75972

* The mean difference is significant at the .05 level.

In room office facilities

Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	57	69.75366	17.06979	3.017541	63.59935	75.90798	37.91055	100
	1	32	73.93461	19.95067	2.642531	68.64098	79.22823	35.15935	100
	2	4	87.04709	11.29878	5.64939	69.06821	105.026	74.11341	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	57	79.58844	16.62636	2.939154	73.594	85.58289	44.96655	100
	1	32	84.02993	18.14484	2.403343	79.21546	88.84441	40.73377	100
	2	4	91.51151	12.20629	6.103146	72.08858	110.9344	74.1134	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	57	71.64379	20.57141	3.636546	64.22701	79.06058	25.7662	100
	1	32	75.34236	19.56257	2.591126	70.15171	80.53301	38.99998	100
	2	4	72.60767	15.26341	7.631707	48.32018	96.89517	51.53219	87.11507
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	57	89.71098	11.258	1.990152	85.65203	93.76992	62.08906	100
	1	32	90.51946	14.25275	1.887822	86.7377	94.30123	42.76984	100
	2	4	97.26888	5.462243	2.731121	88.57723	105.9605	89.07551	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	57	41.69704	22.16367	3.91802	33.70619	49.6879	9.704776	100
	1	32	48.3749	28.40719	3.762624	40.83746	55.91234	5.994269	100
	2	4	37.55896	10.64222	5.321111	20.62481	54.49311	24.0731	49.92875
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	1.937996	2	90	0.149954
ROOM4	1.866485	2	90	0.160604
FB4	0.928059	2	90	0.39907
TOT.OPER	2.511944	2	90	0.086783
MARK.EFF	4.370948	2	90	0.015429

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	1175.976	2	587.9879	1.669085	0.194198
	Within Groups	31705.34	90	352.2815		
	Total	32881.31	92			
ROOM4	Between Groups	719.7874	2	359.8937	1.179822	0.312041
	Within Groups	27453.67	90	305.0408		
	Total	28173.46	92			
FB4	Between Groups	287.9055	2	143.9528	0.367555	0.69346
	Within Groups	35248.47	90	391.6497		
	Total	35536.38	92			
TOT.OPER	Between Groups	203.1216	2	101.5608	0.593753	0.5544
	Within Groups	15394.41	90	171.049		
	Total	15597.53	92			
MARK.EFF	Between Groups	1184.983	2	592.4916	0.877649	0.419287
	Within Groups	60758.07	90	675.0897		
	Total	61943.05	92			

TV based services									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	65	73.05779	19.41879	2.408604	68.24605	77.86953	35.15935	100
	1	19	72.40368	17.99535	4.128417	63.7302	81.07717	40.85955	100
	2	9	74.46134	19.01562	6.338541	59.84464	89.07804	53.54412	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	65	81.03984	18.01757	2.234805	76.5753	85.50437	40.73377	100
	1	19	89.41511	15.98223	3.666574	81.71192	97.1183	61.53988	100
	2	9	81.78954	14.82072	4.940239	70.39733	93.18176	55.21181	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	65	74.60788	19.33632	2.398375	69.81658	79.39919	25.7662	100
	1	19	69.74885	21.09374	4.839236	59.58199	79.91571	41.74108	100
	2	9	78.08953	19.62298	6.540994	63.00597	93.17309	46.82835	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	65	89.51182	14.24821	1.767273	85.98128	93.04235	42.76984	100
	1	19	90.92025	10.47468	2.403057	85.87162	95.96889	68.05326	100
	2	9	97.07592	4.662707	1.554236	93.49185	100.66	89.07551	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	65	46.12131	26.95584	3.34346	39.44199	52.80064	8.215705	100
	1	19	40.31736	24.3981	5.597308	28.55786	52.07687	5.994269	91.43593
	2	9	53.11059	21.41612	7.138706	36.6487	69.57247	26.95784	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.42437	2	90	0.655484
ROOM4	1.455126	2	90	0.238808
FB4	0.167264	2	90	0.846238
TOT.OPER	4.462186	2	90	0.014199
MARK.EFF	1.212157	2	90	0.302366

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	25.85831	2	12.92916	0.035416	0.965217
	Within Groups	32855.45	90	365.0606		
	Total	32881.31	92			
ROOM4	Between Groups	1041.953	2	520.9765	1.728171	0.18345
	Within Groups	27131.51	90	301.4612		
	Total	28173.46	92			
FB4	Between Groups	517.6972	2	258.8486	0.665256	0.516652
	Within Groups	35018.68	90	389.0964		
	Total	35536.38	92			
TOT.OPER	Between Groups	455.921	2	227.9605	1.354971	0.263166
	Within Groups	15141.61	90	168.2401		
	Total	15597.53	92			
MARK.EFF	Between Groups	1055.55	2	527.7751	0.780123	0.461424
	Within Groups	60887.5	90	676.5278		
	Total	61943.05	92			

Ranks			
	TV based services	N	Mean Rank
TOT.OPER	0	65	45.72308
	1	19	45.78947
	2	9	58.77778
	Total	93	

Test Statistics	
	TOT.OPER
Chi-Square	2.17852
df	2
Asymp. Sig.	0.336465
a	Kruskal Wallis Test

Voice mail									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	63	72.61274	18.88941	2.379842	67.85551	77.36998	35.15935	100
	1	27	71.54115	18.60363	3.58027	64.1818	78.9005	40.73374	100
	2	3	96.12148	6.717798	3.878523	79.43354	112.8094	88.36443	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	63	84.21663	16.19879	2.040855	80.13702	88.29624	44.96655	100
	1	27	77.66425	19.78594	3.807806	69.83719	85.49131	40.73377	100
	2	3	100	2.14E-09	1.23E-09	100	100	100	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	63	73.10764	19.16493	2.414554	68.28102	77.93427	25.7662	100
	1	27	74.37833	20.80043	4.003044	66.14995	82.6067	41.74108	100
	2	3	87.85004	21.04434	12.14996	35.573	140.1271	63.55013	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	63	89.45366	12.87306	1.621854	86.21162	92.6957	42.76984	100
	1	27	91.99465	13.7606	2.648228	86.55114	97.43816	52.72462	100
	2	3	100	4.1E-09	2.37E-09	100	100	100	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	63	44.65019	25.93764	3.267835	38.11788	51.18249	9.407036	100
	1	27	45.94821	23.44636	4.512254	36.67314	55.22328	8.215705	91.43593
	2	3	62.7824	49.96522	28.84744	-61.3381	186.9029	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	1.890099	2	90	0.157004
ROOM4	7.520761	2	90	0.000954
FB4	0.711813	2	90	0.493495
TOT.OPER	2.526783	2	90	0.085573
MARK.EFF	2.535434	2	90	0.084875

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	1670.384	2	835.1922	2.408365	0.095739
	Within Groups	31210.93	90	346.7881		
	Total	32881.31	92			
ROOM4	Between Groups	1726.05	2	863.0249	2.936856	0.058134
	Within Groups	26447.41	90	293.8601		
	Total	28173.46	92			
FB4	Between Groups	629.2893	2	314.6446	0.81124	0.447529
	Within Groups	34907.09	90	387.8565		
	Total	35536.38	92			
TOT.OPER	Between Groups	399.9485	2	199.9743	1.184246	0.310699
	Within Groups	15197.58	90	168.862		
	Total	15597.53	92			
MARK.EFF	Between Groups	945.8005	2	472.9003	0.697753	0.500374
	Within Groups	60997.25	90	677.7473		
	Total	61943.05	92			

Ranks			
	Voice mail	N	Mean Rank
ROOM4	0	63	48.61111
	1	27	39.96296
	2	3	76.5
	Total	93	

Test Statistics	
	ROOM4
Chi-Square	5.88299
df	2
Asymp. Sig.	0.052787
a	Kruskal Wallis Test

on demand movies

Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	67	72.17177	19.26218	2.353249	67.47335	76.87018	35.15935	100
	1	19	73.99445	17.61393	4.040912	65.50481	82.48409	40.85955	100
	2	7	79.02501	20.3724	7.700043	60.18368	97.86633	53.54412	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	67	80.57695	18.03353	2.203147	76.17822	84.97567	40.73377	100
	1	19	89.48067	14.1536	3.247059	82.65885	96.30248	62.05953	100
	2	7	86.25634	17.51755	6.62101	70.05531	102.4574	55.21181	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	67	74.35074	19.51917	2.384646	69.58964	79.11184	25.7662	100
	1	19	70.80923	21.32224	4.891658	60.53223	81.08622	43.10006	100
	2	7	78.6674	17.57397	6.642338	62.41419	94.92062	53.5502	97.27832
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	67	89.37581	14.02128	1.712972	85.95575	92.79587	42.76984	100
	1	19	92.23337	10.61096	2.43432	87.11906	97.34769	68.05326	100
	2	7	96.97466	5.170389	1.954223	92.19285	101.7565	89.07551	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	67	44.64709	26.11102	3.189969	38.27811	51.01607	8.215705	100
	1	19	44.95601	26.0731	5.981578	32.38918	57.52284	5.994269	91.43593
	2	7	56.62732	25.12892	9.49784	33.38694	79.86769	26.95784	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.657303	2	90	0.520717
ROOM4	1.902286	2	90	0.155179
FB4	0.401747	2	90	0.670344
TOT.OPER	2.893584	2	90	0.060546
MARK.EFF	0.098949	2	90	0.905887

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	318.5199	2	159.2599	0.440177	0.645301
	Within Groups	32562.79	90	361.8088		
	Total	32881.31	92			
ROOM4	Between Groups	1262.679	2	631.3396	2.111443	0.127021
	Within Groups	26910.78	90	299.0087		
	Total	28173.46	92			
FB4	Between Groups	353.9608	2	176.9804	0.452733	0.637328
	Within Groups	35182.42	90	390.9157		
	Total	35536.38	92			
TOT.OPER	Between Groups	435.1173	2	217.5587	1.291369	0.279938
	Within Groups	15162.41	90	168.4713		
	Total	15597.53	92			
MARK.EFF	Between Groups	919.9168	2	459.9584	0.67837	0.510019
	Within Groups	61023.14	90	678.0349		
	Total	61943.05	92			

				in room internet						
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	65	74.00583	18.11294	2.246633	69.51766	78.49399	35.15935	100
	1	22	72.3563	20.11088	4.287654	63.43963	81.27296	37.91055	100
	2	6	65.39347	24.36882	9.94853	39.81996	90.96699	40.73374	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	65	85.58246	15.22977	1.88902	81.80871	89.35621	51.38844	100
	1	22	78.11649	19.95369	4.254141	69.26952	86.96346	44.96655	100
	2	6	70.19326	24.61072	10.04728	44.3659	96.02063	40.73377	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	65	74.73598	19.14073	2.374115	69.99314	79.47882	38.99998	100
	1	22	72.60012	20.87141	4.4498	63.34626	81.85399	25.7662	100
	2	6	70.4175	23.6043	9.636417	45.64631	95.1887	45.71711	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	65	90.63438	12.37017	1.534331	87.5692	93.69955	42.76984	100
	1	22	91.50627	13.42345	2.861888	85.55465	97.4579	62.08906	100
	2	6	85.84396	19.32241	7.888343	65.56633	106.1216	52.72462	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	65	43.90439	26.12005	3.239794	37.43216	50.37662	5.994269	100
	1	22	50.97828	26.1402	5.573108	39.38837	62.5682	11.08281	100
	2	6	44.43387	24.89054	10.16152	18.31285	70.55489	9.808744	86.54822
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	1.106265	2	90	0.335248
ROOM4	7.27208	2	90	0.051181
FB4	0.242879	2	90	0.784879
TOT.OPER	1.895042	2	90	0.156261
MARK.EFF	0.528704	2	90	0.591187

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	421.6962	2	210.8481	0.584614	0.559423
	Within Groups	32459.62	90	360.6624		
	Total	32881.31	92			
ROOM4	Between Groups	1939.34	2	969.67	3.326595	0.050382
	Within Groups	26234.12	90	291.4902		
	Total	28173.46	92			
FB4	Between Groups	155.1133	2	77.55666	0.197282	0.821313
	Within Groups	35381.26	90	393.1251		
	Total	35536.38	92			
TOT.OPER	Between Groups	153.4301	2	76.71505	0.447054	0.640921
	Within Groups	15444.1	90	171.6011		
	Total	15597.53	92			
MARK.EFF	Between Groups	831.3978	2	415.6989	0.612206	0.544396
	Within Groups	61111.66	90	679.0184		
	Total	61943.05	92			

e-procurement									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	87	72.67946	19.05326	2.042724	68.61866	76.74026	35.15935	100
	1	3	81.00179	16.87325	9.741776	39.08631	122.9173	67.76	100
	2	3	76.15334	20.74944	11.97969	24.60887	127.6978	62.21958	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	87	82.7915	17.74825	1.902812	79.00883	86.57416	40.73377	100
	1	3	87.43748	12.38333	7.14952	56.67558	118.1994	75.24538	100
	2	3	79.13654	18.33019	10.58294	33.60182	124.6713	65.61727	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	87	73.16099	19.49153	2.089711	69.00678	77.31519	25.7662	100
	1	3	74.5357	24.83986	14.3413	12.83006	136.2413	46.82835	94.81167
	2	3	96.31119	6.082197	3.511558	81.20218	111.4202	89.29111	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	87	90.12257	13.27781	1.42353	87.29269	92.95246	42.76984	100
	1	3	92.92417	8.217072	4.744129	72.51183	113.3365	83.91179	100
	2	3	100	3.66E-09	2.12E-09	100	100	100	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	87	45.20171	26.0233	2.78999	39.65539	50.74803	5.994269	100
	1	3	51.43589	22.18152	12.80651	-3.66606	106.5378	26.35825	68.48625
	2	3	51.68474	35.29699	20.37873	-35.9979	139.3673	11.08281	75.0663
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.243996	2	90	0.784007
ROOM4	1.363241	2	90	0.261061
FB4	2.232545	2	90	0.113162
TOT.OPER	3.261291	2	90	0.052915
MARK.EFF	0.394167	2	90	0.6754

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	230.5212	2	115.2606	0.317709	0.728627
	Within Groups	32650.79	90	362.7866		
	Total	32881.31	92			
ROOM4	Between Groups	104.7367	2	52.36834	0.167915	0.84569
	Within Groups	28068.72	90	311.8747		
	Total	28173.46	92			
FB4	Between Groups	1555.259	2	777.6293	2.059574	0.133476
	Within Groups	33981.12	90	377.568		
	Total	35536.38	92			
TOT.OPER	Between Groups	300.6804	2	150.3402	0.884536	0.416464
	Within Groups	15296.85	90	169.965		
	Total	15597.53	92			
MARK.EFF	Between Groups	227.033	2	113.5165	0.16554	0.847693
	Within Groups	61716.02	90	685.7336		
	Total	61943.05	92			

e-lock system									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	52	71.51041	19.10767	2.649757	66.1908	76.83002	35.15935	100
	1	19	71.28521	18.52701	4.250387	62.35548	80.21495	40.85955	100
	2	22	78.25536	18.64969	3.976128	69.98655	86.52417	50.05984	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	52	80.32822	18.13158	2.514397	75.28036	85.37609	40.73377	100
	1	19	85.10325	17.02065	3.904805	76.89956	93.30694	51.38844	100
	2	22	86.75241	16.08051	3.428376	79.62271	93.88211	50.05986	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	52	72.76992	18.69885	2.593064	67.56413	77.97572	25.7662	100
	1	19	70.15414	21.61355	4.958489	59.73674	80.57154	43.10006	100
	2	22	80.02644	19.68474	4.1968	71.29872	88.75416	41.74108	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	52	87.47256	14.91392	2.068189	83.3205	91.62462	42.76984	100
	1	19	92.02617	10.344	2.373077	87.04053	97.01182	70.08228	100
	2	22	96.47117	6.978595	1.487841	93.37703	99.5653	73.26363	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	52	44.41353	28.29299	3.923532	36.53671	52.29034	8.215705	100
	1	19	44.16893	22.30148	5.11631	33.41996	54.9179	14.19837	91.43593
	2	22	49.6908	23.58897	5.029185	39.23204	60.14957	5.994269	100
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.372911	2	90	0.689786
ROOM4	0.909482	2	90	0.406402
FB4	0.457022	2	90	0.634628
TOT.OPER	7.700811	2	90	0.050818
MARK.EFF	1.784592	2	90	0.173754

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	778.5304	2	389.2652	1.091303	0.34018
	Within Groups	32102.78	90	356.6976		
	Total	32881.31	92			
ROOM4	Between Groups	762.1198	2	381.0599	1.251139	0.291108
	Within Groups	27411.34	90	304.5704		
	Total	28173.46	92			
FB4	Between Groups	1158.484	2	579.2421	1.516434	0.225048
	Within Groups	34377.89	90	381.9766		
	Total	35536.38	92			
TOT.OPER	Between Groups	1305.168	2	652.584	4.109367	0.019596
	Within Groups	14292.36	90	158.804		
	Total	15597.53	92			
MARK.EFF	Between Groups	480.2622	2	240.1311	0.351624	0.704507
	Within Groups	61462.79	90	682.9199		
	Total	61943.05	92			

Multiple Comparisons-Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) XO18	(J) XO18				Lower Bound	Upper Bound
TOT.OPER	0	1	-4.55361	3.37817	0.406798	-12.9621	3.854839
		2	-8.9986	3.205041	0.022862	-16.9761	-1.02108
	1	0	4.553612	3.37817	0.406798	-3.85484	12.96206
		2	-4.44499	3.946704	0.5327	-14.2686	5.378573
	2	0	8.998604	3.205041	0.022862	1.021079	16.97613
		1	4.444991	3.946704	0.5327	-5.37857	14.26856

* The mean difference is significant at the .05 level.

energy management system									
Descriptives		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
ROOM3	0	82	72.50829	18.86986	2.083828	68.36213	76.65446	35.15935	100
	1	8	77.55476	20.5744	7.27415	60.35413	94.7554	51.38844	100
	2	3	76.15334	20.74944	11.97969	24.60887	127.6978	62.21958	100
	Total	93	73.05998	18.90517	1.960375	69.16651	76.95345	35.15935	100
ROOM4	0	82	83.21045	17.23914	1.903745	79.42259	86.9983	40.73377	100
	1	8	80.23952	21.78717	7.702928	62.02498	98.45405	51.38844	100
	2	3	79.13654	18.33019	10.58294	33.60182	124.6713	65.61727	100
	Total	93	82.82347	17.49952	1.814616	79.21948	86.42745	40.73377	100
FB4	0	82	72.8328	19.59648	2.164069	68.52698	77.13862	25.7662	100
	1	8	77.0404	19.55863	6.915018	60.68898	93.39182	51.53219	100
	2	3	96.31119	6.082197	3.511558	81.20218	111.4202	89.29111	100
	Total	93	73.95211	19.65362	2.037986	69.9045	77.99973	25.7662	100
TOT.OPER	0	82	89.7128	13.4021	1.480014	86.76804	92.65756	42.76984	100
	1	8	95.37332	8.759952	3.097111	88.04982	102.6968	78.07209	100
	2	3	100	3.66E-09	2.12E-09	100	100	100	100
	Total	93	90.53157	13.02069	1.350183	87.84999	93.21315	42.76984	100
MARK.EFF	0	82	45.36167	25.26767	2.790348	39.80975	50.91359	5.994269	100
	1	8	45.89993	32.99347	11.66495	18.3167	73.48317	8.215705	100
	2	3	51.68474	35.29699	20.37873	-35.9979	139.3673	11.08281	75.0663
	Total	93	45.61194	25.94791	2.690673	40.26803	50.95585	5.994269	100

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
ROOM3	0.142782	2	90	0.867139
ROOM4	1.320452	2	90	0.272137
FB4	2.334405	2	90	0.102707
TOT.OPER	3.551051	2	90	0.052781
MARK.EFF	1.003217	2	90	0.370761

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
ROOM3	Between Groups	215.2887	2	107.6444	0.296577	0.744082
	Within Groups	32666.02	90	362.9558		
	Total	32881.31	92			
ROOM4	Between Groups	106.4745	2	53.23724	0.170711	0.843337
	Within Groups	28066.99	90	311.8554		
	Total	28173.46	92			
FB4	Between Groups	1678.82	2	839.4098	2.231315	0.113295
	Within Groups	33857.56	90	376.1951		
	Total	35536.38	92			
TOT.OPER	Between Groups	511.4652	2	255.7326	1.525642	0.223052
	Within Groups	15086.07	90	167.623		
	Total	15597.53	92			
MARK.EFF	Between Groups	116.4363	2	58.21815	0.084747	0.918818
	Within Groups	61826.62	90	686.9624		
	Total	61943.05	92			

F.3.2 Appendix
Chi-square for investigating the effect of ICT PMS integration on market efficiency in rooms division

0= no ICT availability
1= ICT availability
2= ICT availability and PMS integration

			Customer Database, XO24			Total
			0	1	2	
MARK. ONL	inefficient	Count	21	12	27	60
		% within XO24	80.76923	48	64.28571	64.51613
	efficient	Count	5	13	15	33
		% within XO24	19.23077	52	35.71429	35.48387
Total		Count	26	25	42	93
		% within XO24	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.980058	2	0.050286
Likelihood Ratio	6.151061	2	0.046165
Linear-by-Linear Association	1.237454	1	0.265962
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.87.

			YM, XO2			Total
			0	1	2	
MARK. ONL	inefficient	Count	32	9	19	60
		% within XO2	71.11111	56.25	59.375	64.51613
	efficient	Count	13	7	13	33
		% within XO2	28.88889	43.75	40.625	35.48387
Total		Count	45	16	32	93
		% within XO2	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.701967	2	0.426995
Likelihood Ratio	1.709028	2	0.42549
Linear-by-Linear Association	1.223026	1	0.268768
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.68.

			GDS, XO1			Total
			0	1	2	
MARK. ONL	inefficient	Count	32	24	4	60
		% within XO1	69.56522	60	57.14286	64.51613
	efficient	Count	14	16	3	33
		% within XO1	30.43478	40	42.85714	35.48387
Total		Count	46	40	7	93
		% within XO1	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.03485	2	0.596053
Likelihood Ratio	1.036707	2	0.5955
Linear-by-Linear Association	0.950235	1	0.32966
N of Valid Cases	93		

a 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.48.

			CRS, XO28			Total
			0	1	2	
MARK. ONL	inefficient	Count	21	22	17	60
		% within XO28	75	66.66667	53.125	64.51613
	efficient	Count	7	11	15	33
		% within XO28	25	33.33333	46.875	35.48387
Total		Count	28	33	32	93
		% within XO28	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.224763	2	0.199412
Likelihood Ratio	3.235618	2	0.198333
Linear-by-Linear Association	3.127796	1	0.076968
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.94.

			PBRS, XO3			Total
			0	1	2	
MARK. ONL	inefficient	Count	16	8	36	60
		% within XO3	69.56522	47.05882	67.92453	64.51613
	efficient	Count	7	9	17	33
		% within XO3	30.43478	52.94118	32.07547	35.48387
Total		Count	23	17	53	93
		% within XO3	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.788182	2	0.248058
Likelihood Ratio	2.689034	2	0.260666
Linear-by-Linear Association	0.027119	1	0.869196
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.03.

			Marketing and Sales, XO26			Total
			0	1	2	
MARK. ONL	inefficient	Count	34	9	17	60
		% within XO26	65.38462	60	65.38462	64.51613
	efficient	Count	18	6	9	33
		% within XO26	34.61538	40	34.61538	35.48387
Total		Count	52	15	26	93
		% within XO26	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.159336	2	0.923423
Likelihood Ratio	0.157138	2	0.924438
Linear-by-Linear Association	0.003115	1	0.955491
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.32.

			Telephone systems, XO20			Total
			0	1	2	
MARK. ONL	inefficient	Count	14	16	30	60
		% within XO20	77.77778	55.17241	65.21739	64.51613
	efficient	Count	4	13	16	33
		% within XO20	22.22222	44.82759	34.78261	35.48387
Total		Count	18	29	46	93
		% within XO20	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.498666	2	0.286696
Likelihood Ratio	2.571274	2	0.276474
Linear-by-Linear Association	0.331438	1	0.564813
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.39.

			Check in/out kiosks, XO4			Total
			0	1	2	
MARK. ONL	inefficient	Count	55	1	4	60
		% within XO4	67.07317	25	57.14286	64.51613
	efficient	Count	27	3	3	33
		% within XO4	32.92683	75	42.85714	35.48387
Total		Count	82	4	7	93
		% within XO4	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.128845	2	0.209209
Likelihood Ratio	2.993149	2	0.223896
Linear-by-Linear Association	1.034574	1	0.309087
N of Valid Cases	93		

a 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.42.

			Finance & Accounting, XO6			Total
			0	1	2	
MARK. ONL	inefficient	Count	15	12	33	60
		% within XO6	75	57.14286	63.46154	64.51613
	efficient	Count	5	9	19	33
		% within XO6	25	42.85714	36.53846	35.48387
Total		Count	20	21	52	93
		% within XO6	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.484191	2	0.476115
Likelihood Ratio	1.525947	2	0.466278
Linear-by-Linear Association	0.495743	1	0.481377
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.10.

			Conference & Banq, XO7			Total
			0	1	2	
MARK. ONL	inefficient	Count	43	7	10	60
		% within XO7	71.66667	50	52.63158	64.51613
	efficient	Count	17	7	9	33
		% within XO7	28.33333	50	47.36842	35.48387
Total		Count	60	14	19	93
		% within XO7	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.800961	2	0.149497
Likelihood Ratio	3.748717	2	0.153453
Linear-by-Linear Association	3.04145	1	0.081163
N of Valid Cases	93		

a 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.97.

			FB ICT, XO8			Total
			0	1	2	
MARK. ONL	inefficient	Count	34	13	13	60
		% within XO8	65.38462	61.90476	65	64.51613
	efficient	Count	18	8	7	33
		% within XO8	34.61538	38.09524	35	35.48387
Total		Count	52	21	20	93
		% within XO8	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.081732	2	0.959958
Likelihood Ratio	0.081151	2	0.960236
Linear-by-Linear Association	0.008921	1	0.924751
N of Valid Cases	93		

A 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.10.

			Stock & Inventory, XO9			Total
			0	1	2	
MARK. ONL	inefficient	Count	33	14	13	60
		% within XO9	73.33333	56	56.52174	64.51613
	efficient	Count	12	11	10	33
		% within XO9	26.66667	44	43.47826	35.48387
Total		Count	45	25	23	93
		% within XO9	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.962277	2	0.227379
Likelihood Ratio	2.991455	2	0.224086
Linear-by-Linear Association	2.32005	1	0.127716
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.16.

			EPOS, XO10			Total
			0	1	2	
MARK. ONL	inefficient	Count	24	10	26	60
		% within XO10	70.58824	55.55556	63.41463	64.51613
	efficient	Count	10	8	15	33
		% within XO10	29.41176	44.44444	36.58537	35.48387
Total		Count	34	18	41	93
		% within XO10	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.200636	2	0.548637
Likelihood Ratio	1.197429	2	0.549518
Linear-by-Linear Association	0.367343	1	0.544456
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.39.

			Automated mini-bars, XO11			Total
			0	1	2	
MARK. ONL	inefficient	Count	56	2	2	60
		% within XO11	65.11628	50	66.66667	64.51613
	efficient	Count	30	2	1	33
		% within XO11	34.88372	50	33.33333	35.48387
Total		Count	86	4	3	93
		% within XO11	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.387773	2	0.823751
Likelihood Ratio	0.371894	2	0.830318
Linear-by-Linear Association	0.059052	1	0.808001
N of Valid Cases	93		

a 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.06.

			In-room Office facilities, XO12			Total
			0	1	2	
MARK. ONL	inefficient	Count	34	14	2	50
		% within XO12	0.596491	0.4375	0.5	0.537634
	efficient	Count	23	18	2	43
		% within XO12	0.403509	0.5625	0.5	0.462366
Total		Count	57	32	4	93
		% within XO12	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.494338	2	0.287317
Likelihood Ratio	2.555438	2	0.278672
Linear-by-Linear Association	2.427542	1	0.11922
N of Valid Cases	93		

a 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.42.

			TV based services, XO13			Total
			0	1	2	
MARK. ONL	inefficient	Count	46	7	7	60
		% within XO13	70.76923	36.84211	77.77778	64.51613
	efficient	Count	19	12	2	33
		% within XO13	29.23077	63.15789	22.22222	35.48387
Total		Count	65	19	9	93
		% within XO13	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.157844	2	0.016926
Likelihood Ratio	7.883113	2	0.019418
Linear-by-Linear Association	0.884255	1	0.347039
N of Valid Cases	93		

a 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.19.

			Voice mail, XO14			Total
			0	1	2	
MARK. ONL	inefficient	Count	41	19		60
		% within XO14	65.07937	70.37037		64.51613
	efficient	Count	22	8	3	33
		% within XO14	34.92063	29.62963	100	35.48387
Total		Count	63	27	3	93
		% within XO14	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.867484	2	0.053198
Likelihood Ratio	6.641016	2	0.036134
Linear-by-Linear Association	0.830597	1	0.3621
N of Valid Cases	93		

a 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.06.

			On-demand movies, XO15			Total
			0	1	2	
MARK. ONL	inefficient	Count	47	9	4	60
		% within XO15	70.14925	47.36842	57.14286	64.51613
	efficient	Count	20	10	3	33
		% within XO15	29.85075	52.63158	42.85714	35.48387
Total		Count	67	19	7	93
		% within XO15	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.535362	2	0.170728
Likelihood Ratio	3.439363	2	0.179123
Linear-by-Linear Association	2.253875	1	0.13328
N of Valid Cases	93		

a 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.48.

			In room Internet, XO16			Total
			0	1	2	
MARK. ONL	inefficient	Count	41	14	5	60
		% within XO16	63.07692	63.63636	83.33333	64.51613
	efficient	Count	24	8	1	33
		% within XO16	36.92308	36.36364	16.66667	35.48387
Total		Count	65	22	6	93
		% within XO16	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.99428	2	0.608268
Likelihood Ratio	1.113875	2	0.572961
Linear-by-Linear Association	0.548646	1	0.458871
N of Valid Cases	93		

a 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.13.

			e-procurement, XO17			Total
			0	1	2	
MARK. ONL	inefficient	Count	56	2	2	60
		% within XO17	64.36782	66.66667	66.66667	64.51613
	efficient	Count	31	1	1	33
		% within XO17	35.63218	33.33333	33.33333	35.48387
Total		Count	87	3	3	93
		% within XO17	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.012957	2	0.993542
Likelihood Ratio	0.013073	2	0.993485
Linear-by-Linear Association	0.011457	1	0.914759
N of Valid Cases	93		

a 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.06.

			e-lock systems, XO18			Total
			0	1	2	
MARK. ONL	inefficient	Count	38	10	12	60
		% within XO18	73.07692	52.63158	54.54545	64.51613
	efficient	Count	14	9	10	33
		% within XO18	26.92308	47.36842	45.45455	35.48387
Total		Count	52	19	22	93
		% within XO18	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.792306	2	0.150145
Likelihood Ratio	3.790122	2	0.150309
Linear-by-Linear Association	2.96656	1	0.085002
N of Valid Cases	93		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.74.

			Energy management systems, XO19			Total
			0	1	2	
MARK. ONL	inefficient	Count	54	4	2	60
		% within XO19	65.85366	50	66.66667	64.51613
	efficient	Count	28	4	1	33
		% within XO19	34.14634	50	33.33333	35.48387
Total		Count	82	8	3	93
		% within XO19	100	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.806504	2	0.668144
Likelihood Ratio	0.774992	2	0.678754
Linear-by-Linear Association	0.257343	1	0.611952
N of Valid Cases	93		

a 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.06.

			Videoconferencing, XO21		Total
			0	1	
MARK. ONL	inefficient	Count	57	3	60
		% within XO21	64.77273	60	64.51613
	efficient	Count	31	2	33
		% within XO21	35.22727	40	35.48387
Total		Count	88	5	93
		% within XO21	100	100	100

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.047076	1	0.828231
Likelihood Ratio	0.046314	1	0.829605
Linear-by-Linear Association	0.04657	1	0.829143
N of Valid Cases	93		

a Computed only for a 2x2 table

b 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.77.

F.3.3 Appendix
The productivity impact of systems' integration within clusters of ICT
Effect of systems integration of ICT clusters on Room 3, Room 4, FB4, Tot.oper and Mark.eff
Correlations

(N=78 units with PMS)

% of ICT PMS integrated within cluster:		ROOM3	ROOM4	FB4	TOT.OPER	MARK.EFF
1	Pearson Correlation	0.058194	0.006592	0.104745	0.089853	-0.03701
	Sig. (2-tailed)	*0.612796*	*0.954325*	*0.361419*	*0.434017*	*0.747655*
2	Pearson Correlation	0.029262	-0.11188	0.232181	0.110413	-0.02554
	Sig. (2-tailed)	*0.79925*	*0.329461*	*0.041863*	*0.335878*	*0.824317*
3	Pearson Correlation	0.116464	0.072196	0.08217	0.165626	0.009323
	Sig. (2-tailed)	*0.351722*	*0.56457*	*0.511884*	*0.183835*	*0.940774*
4	Pearson Correlation	0.058682	-0.0713	0.195591	0.111623	-0.17349
	Sig. (2-tailed)	*0.609817*	*0.535069*	*0.086135*	*0.330577*	*0.128747*
5	Pearson Correlation	0.105271	0.049936	[redacted]	0.079606	0.020824
	Sig. (2-tailed)	*0.375412*	*0.674812*	*0.008962*	*0.503189*	*0.861184*
6	Pearson Correlation	0.139504	-0.01738	0.242104	0.178929	-0.02295
	Sig. (2-tailed)	*0.22317*	*0.879922*	*0.032715*	*0.117017*	*0.841922*
7	Pearson Correlation	0.11965	-0.04005	[redacted]	0.160325	-0.08659
	Sig. (2-tailed)	*0.296755*	*0.727717*	*0.013289*	*0.160862*	*0.450965*
9	Pearson Correlation	0.005095	-0.0385	0.253459	0.07658	0.019398
	Sig. (2-tailed)	*0.966611*	*0.751665*	*0.046017*	*0.528628*	*0.873361*
x integr + i integr	Pearson Correlation	0.201203	0.090741	0.231957	[redacted]	0.1634
	Sig. (2-tailed)	*0.077329*	*0.42947*	*0.041006*	*0.015545*	*0.15288*

[redacted] Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

F.3.4 Effect of integration of cluster of ICT on market efficiency in rooms division
T-tests

	MARK.ONL	N	Mean	Std. Deviation	Std. Error Mean
% of distribution ICT integrated with PMS	inefficient	51	0.434967	0.320213	0.044839
	efficient	27	0.460494	0.305195	0.058735
% of reservation ICT integrated with PMS	inefficient	51	0.510854	0.335842	0.047027
	efficient	27	0.488624	0.306653	0.059015
% of in room ICT integrated with PMS	inefficient	40	0.150417	0.289451	0.045766
	efficient	26	0.177564	0.312123	0.061212
% of room division ICT integrated with PMS	inefficient	51	0.689597	0.335584	0.046991
	efficient	27	0.647619	0.271742	0.052297
% of FB integrated with PMS	inefficient	47	0.479433	0.438572	0.063972
	efficient	26	0.535256	0.4131	0.081016
% of non FB integrated with PMS	inefficient	51	0.406783	0.18844	0.026387
	efficient	27	0.395043	0.182464	0.035115
% of general ICT integrated with PMS	inefficient	45	0.633333	0.421337	0.062809
	efficient	25	0.578667	0.385156	0.077031
% of all ICT integrated with PMS	inefficient	51	0.55924	0.258366	0.036178
	efficient	27	0.51964	0.229518	0.044171

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1	Equal variances assumed	0.172	0.679	-0.340	76.000	0.735	-0.026	0.075	-0.175	0.124
	Equal variances not assumed			-0.345	55.359	0.731	-0.026	0.074	-0.174	0.123
2	Equal variances assumed	0.536	0.466	0.286	76.000	0.775	0.022	0.078	-0.132	0.177
	Equal variances not assumed			0.295	57.456	0.769	0.022	0.075	-0.129	0.173
3	Equal variances assumed	0.094	0.760	-0.361	64.000	0.719	-0.027	0.075	-0.177	0.123
	Equal variances not assumed			-0.355	50.622	0.724	-0.027	0.076	-0.181	0.126
4	Equal variances assumed	2.654	0.107	0.560	76.000	0.577	0.042	0.075	-0.107	0.191
	Equal variances not assumed			0.597	63.431	0.553	0.042	0.070	-0.099	0.182
9	Equal variances assumed	1.404	0.240	0.536	68.000	0.594	0.055	0.102	-0.149	0.258
	Equal variances not assumed			0.550	53.598	0.585	0.055	0.099	-0.145	0.254
% of all ICT PMS	Equal variances assumed	0.301	0.585	0.669	76.000	0.506	0.040	0.059	-0.078	0.158
	Equal variances not assumed			0.694	58.820	0.491	0.040	0.057	-0.075	0.154
5	Equal variances assumed	0.234	0.630	-0.531	71.000	0.597	-0.056	0.105	-0.265	0.154
	Equal variances not assumed			-0.541	54.401	0.591	-0.056	0.103	-0.263	0.151
6	Equal variances assumed	0.001	0.978	0.265	76.000	0.792	0.012	0.044	-0.077	0.100
	Equal variances not assumed			0.267	54.600	0.790	0.012	0.044	-0.076	0.100

F.3.5 Effect of systems integration of single ICT on Room 3, Room 4, FB4, Tot.oper and Mark.eff
Pearson correlations

Systems integration productivity effect for PMS holders and non holders

PMS	ICT		ROOM3	ROOM4	FB4	TOT.OPER	MARK.EFF
No (15)	FO	Pearson Correlation	-0.50923	-0.32451	0.201405	-0.28069	-0.40843
		Sig. (2-tailed)	*0.052523*	*0.237979*	*0.471652*	*0.310882*	*0.130675*
		N	*9*	*9*	*9*	*9*	*9*
Yes (78)	FO	Pearson Correlation	-0.21647	0.042199	-0.19097	-0.12797	-0.19799
		Sig. (2-tailed)	*0.060359*	*0.717392*	*0.098434*	*0.270617*	*0.086443*
		N	*77*	*77*	*77*	*77*	*77*
	CRS	Pearson Correlation	-0.00208	0.053449	-0.1628	0.037368	0.079468
		Sig. (2-tailed)	*0.985588*	*0.642106*	*0.154406*	*0.745322*	*0.489184*
		N	*58*	*58*	*58*	*58*	*58*
	PBRS	Pearson Correlation	0.079961	-0.01819	-0.19311	0.053551	0.088035
		Sig. (2-tailed)	*0.486484*	*0.874431*	*0.090268*	*0.641468*	*0.443412*
		N	*65*	*65*	*65*	*65*	*65*
	YM	Pearson Correlation	-0.0152	0.052203	0.089814	0.227661	0.083067
		Sig. (2-tailed)	*0.894892*	*0.649894*	*0.43422*	*0.045007*	*0.46966*
		N	*44*	*44*	*44*	*44*	*44*
	GDS	Pearson Correlation	0.001888	-0.00049	-0.01669	0.07626	0.064124
		Sig. (2-tailed)	*0.986915*	*0.996586*	*0.88469*	*0.506941*	*0.577007*
		N	*42*	*42*	*42*	*42*	*42*
	M&S	Pearson Correlation	-0.00953	-0.17885	0.168968	0.097272	-0.13932
		Sig. (2-tailed)	*0.933984*	*0.117176*	*0.139182*	*0.396868*	*0.223786*
		N	*38*	*38*	*38*	*38*	*38*
	Guest dat/bse	Pearson Correlation	0.022623	-0.11094	0.234564	0.060003	0.013796
		Sig. (2-tailed)	*0.844138*	*0.333565*	*0.038724*	*0.601774*	*0.90458*
		N	*61*	*61*	*61*	*61*	*61*
	F&A	Pearson Correlation	-0.04475	-0.07983	0.133087	0.051586	-0.00053
		Sig. (2-tailed)	*0.708939*	*0.505043*	*0.26507*	*0.666944*	*0.996471*
		N	*65*	*65*	*65*	*65*	*65*
	Conf & Banq	Pearson Correlation	0.022656	-0.09235	-0.10677	-0.09838	0.051695
		Sig. (2-tailed)	*0.85017*	*0.440382*	*0.372046*	*0.410994*	*0.666281*
		N	*32*	*32*	*32*	*32*	*32*
	FB	Pearson Correlation	-0.04204	-0.08485	0.208538	0.089371	0.066009
		Sig. (2-tailed)	*0.725861*	*0.478516*	*0.078761*	*0.455328*	*0.581698*
		N	*41*	*41*	*41*	*41*	*41*
	EPOS	Pearson Correlation	0.185725	0.196599	0.042516	-0.03215	0.010269
		Sig. (2-tailed)	*0.118294*	*0.097884*	*0.722885*	*0.788615*	*0.931773*
		N	*53*	*53*	*53*	*53*	*53*
	Stock & Inv.	Pearson Correlation	0.210342	0.074375	0.113195	0.020191	0.257154
		Sig. (2-tailed)	*0.07615*	*0.534661*	*0.343779*	*0.866315*	*0.029209*
		N	*46*	*46*	*46*	*46*	*46*

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

F.3.6 Effect of systems integration of single ICT on market efficiency in rooms division only
t-tests

Systems integration productivity effect for PMS holders and non holders

PMS		MARK.ONL	N	Mean	Std. Deviation	Std. Error Mean
No (15)	FO	inefficient	5	0.8	1.30384	0.583095
		efficient	4	3.75	5.188127	2.594064
Yes (78)	FO	inefficient	48	0.220755	0.477441	0.068913
		efficient	27	0.246815	0.178396	0.034332
	CRS	inefficient	35	0.141565	0.18495	0.031262
		efficient	23	0.132471	0.145201	0.030277
	PBRS	inefficient	42	0.131368	0.074987	0.011571
		efficient	23	0.110802	0.104072	0.021701
	YM	inefficient	26	0.12094	0.095631	0.018755
		efficient	18	0.113428	0.125646	0.029615
	GDS	inefficient	26	0.076221	0.102039	0.020011
		efficient	16	0.048611	0.10277	0.025693
	Market sales syst.	inefficient	23	0.103847	0.078028	0.01627
		efficient	15	0.059074	0.051031	0.013176
	Customer Databases	inefficient	36	0.106349	0.07026	0.01171
		efficient	25	0.072192	0.070534	0.014107
	F&A ICT	inefficient	39	0.381695	0.296281	0.047443
		efficient	23	0.279365	0.269054	0.056102
	Conf. & Banq. ICT	inefficient	17	0.209477	0.239916	0.058188
		efficient	15	0.145026	0.178294	0.046035
	FB	inefficient	25	0.204444	0.193056	0.038611
		efficient	15	0.158042	0.260709	0.067315
	EPOS	inefficient	32	0.331076	0.246257	0.043532
		efficient	20	0.198889	0.166573	0.037247
	Stock & Inventory	inefficient	26	0.170299	0.183496	0.035987
		efficient	19	0.103718	0.115911	0.026592

			Levene's Test for Equality of Variances		t-test for Equality of Means						
			F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
PMS										Lower	Upper
NO (15)	FO.1	Equal variances assumed	4.536	0.071	1.243	7.000	0.254	2.950	2.372	-2.660	8.560
		Equal variances not assumed			1.110	3.304	0.341	2.950	2.659	-5.087	10.987
Yes (78)	FO	Equal variances assumed	0.915	0.342	-0.272	73.000	0.786	-0.026	0.096	-0.217	0.165
		Equal variances not assumed			-0.338	65.889	0.736	-0.026	0.077	-0.180	0.128
	CRS	Equal variances assumed	0.049	0.826	0.199	56.000	0.843	0.009	0.046	-0.083	0.101
		Equal variances not assumed			0.209	54.116	0.835	0.009	0.044	-0.078	0.096
	PBRS	Equal variances assumed	1.844	0.179	0.919	63.000	0.362	0.021	0.022	-0.024	0.065
		Equal variances not assumed			0.836	34.779	0.409	0.021	0.025	-0.029	0.071
	YM	Equal variances assumed	0.644	0.427	0.225	42.000	0.823	0.008	0.033	-0.060	0.075
		Equal variances not assumed			0.214	30.080	0.832	0.008	0.035	-0.064	0.079
	GDS	Equal variances assumed	0.535	0.469	0.849	40.000	0.401	0.028	0.033	-0.038	0.093
		Equal variances not assumed			0.848	31.717	0.403	0.028	0.033	-0.039	0.094
	Market & Sales	Equal variances assumed	1.023	0.319	1.961	36.000	0.058	0.045	0.023	-0.002	0.091
		Equal variances not assumed			2.139	35.992	0.039	0.045	0.021	0.002	0.087
	Database	Equal variances assumed	0.274	0.602	1.864	59.000	0.067	0.034	0.018	-0.003	0.071
		Equal variances not assumed			1.863	51.653	0.068	0.034	0.018	-0.003	0.071
	F & A ICT	Equal variances assumed	0.782	0.380	1.358	60.000	0.180	0.102	0.075	-0.048	0.253
		Equal variances not assumed			1.393	49.933	0.170	0.102	0.073	-0.045	0.250
	Conf. & Banq	Equal variances assumed	0.293	0.592	0.853	30.000	0.401	0.064	0.076	-0.090	0.219
		Equal variances not assumed			0.869	29.216	0.392	0.064	0.074	-0.087	0.216
	FB ICT	Equal variances assumed	0.004	0.952	0.645	38.000	0.523	0.046	0.072	-0.099	0.192
		Equal variances not assumed			0.598	23.259	0.556	0.046	0.078	-0.114	0.207
	EPOS	Equal variances assumed	1.817	0.184	2.114	50.000	0.040	0.132	0.063	0.007	0.258
		Equal variances not assumed			2.307	49.617	0.025	0.132	0.057	0.017	0.247
	Stock & Inventory	Equal variances assumed	5.742	0.021	1.390	43.000	0.172	0.067	0.048	-0.030	0.163
		Equal variances not assumed			1.488	42.257	0.144	0.067	0.045	-0.024	0.157

Appendix F.4
Effect of sophistication on efficiency
F.4.1 Pearson correlations

		ROOM3	ROOM4	FB4	TOT.OPER	MARK.EFF
PMS sophistication	Pearson Correlation	0.176449	[redacted]	0.150995	0.114267	0.192773
	Sig. (2-tailed)	*0.122263*	*0.006021*	*0.186967*	*0.319176*	*0.090849*
	N	*78*	*78*	*78*	*78*	*78*
WEB.SOPH	Pearson Correlation	0.207716	0.057248	0.201527	0.144106	0.159373
	Sig. (2-tailed)	*0.052146*	*0.596256*	*0.059724*	*0.180404*	*0.13803*
	N	*88*	*88*	*88*	*88*	*88*
EML.SOPH	Pearson Correlation	0.008607	-0.01138	-0.06143	0.075805	0.109919
	Sig. (2-tailed)	*0.935466*	*0.914725*	*0.562968*	*0.475123*	*0.299635*
	N	*91*	*91*	*91*	*91*	*91*
INTR.SOP	Pearson Correlation	0.275376	0.168732	0.112134	0.07893	0.279251
	Sig. (2-tailed)	*0.040789*	*0.372752*	*0.555224*	*0.678439*	*0.135061*
	N	*30*	*30*	*30*	*30*	*30*
DAT.SOPH	Pearson Correlation	[redacted]	0.252039	[redacted]	0.241067	0.259459
	Sig. (2-tailed)	*0.00995*	*0.032696*	*0.000201*	*0.041359*	*0.027743*
	N	*72*	*72*	*72*	*72*	*72*

* Correlation is significant at the 0.05 level (2-tailed).
[redacted] Correlation is significant at the 0.01 level (2-tailed).

F.4.2 Effect of sophistication on market efficiency in rooms division
T-tests

	Market.only	No.	Efficiency score	Mean	St.Dev
PMS sophistication	inefficient	51	9.215686	5.964273	0.835165
	efficient	27	14.66667	4.305631	0.828619
WEB.SOPH	inefficient	58	6.517241	4.713703	0.61894
	efficient	30	8.166667	5.813678	1.061428
EML.SOPH	inefficient	60	7.466667	4.556488	0.58824
	efficient	31	8.709677	5.435645	0.976271
INTR.SOP	inefficient	14	6.571429	3.588749	0.959134
	efficient	16	9.1875	5.127946	1.281987
DAT.SOPH	inefficient	45	6.733333	4.960755	0.739506
	efficient	27	7.703704	6.637972	1.277478

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PMS sophi	Equal variances assumed	4.775	0.032	-4.199	76.000	0.000	-5.451	1.298	-8.036	-2.866
	Equal variances not assumed			-4.633	68.759	0.000	-5.451	1.176	-7.798	-3.104
WEB.SOPH	Equal variances assumed	3.426	0.068	-1.435	86.000	0.155	-1.649	1.149	-3.934	0.636
	Equal variances not assumed			-1.342	49.182	0.186	-1.649	1.229	-4.118	0.820
EML.SOPH	Equal variances assumed	3.610	0.061	-1.154	89.000	0.252	-1.243	1.077	-3.384	0.898
	Equal variances not assumed			-1.091	52.236	0.280	-1.243	1.140	-3.530	1.044
INTR.SOPH	Equal variances assumed	2.953	0.097	-1.596	28.000	0.122	-2.616	1.639	-5.974	0.742
	Equal variances not assumed			-1.634	26.803	0.114	-2.616	1.601	-5.902	0.670
DAT.SOPH	Equal variances assumed	4.588	0.036	-0.706	70.000	0.482	-0.970	1.373	-3.710	1.769
	Equal variances not assumed			-0.657	43.461	0.514	-0.970	1.476	-3.946	2.006

F.4.3 Appendix
Cross tabulations for investigating the efficiency effect of specific features of ICT sophistication of use

PMS and Rooms4

			PMS for front office automation		Total
			No	Yes	
Rooms4	Efficient	Count	1	26	27
		Expected Count	1.038462	25.96154	27
		% within PMS.FRON	33.33333	34.66667	34.61538
		Std. Residual	-0.03774	0.007549	
	above	Count	1	26	27
		Expected Count	1.038462	25.96154	27
		% within PMS.FRON	33.33333	34.66667	34.61538
		Std. Residual	-0.03774	0.007549	
	below	Count	1	23	24
		Expected Count	0.923077	23.07692	24
		% within PMS.FRON	33.33333	30.66667	30.76923
		Std. Residual	0.080064	-0.01601	
Total		Count	3	75	78
		Expected Count	3	75	78
		% within PMS.FRON	100	100	100

Chi-Square Tests

PMS		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	0.00963	2	0.995197
	Likelihood Ratio	0.009495	2	0.995264
	Linear-by-Linear Association	0.006984	1	0.933397
	N of Valid Cases	78		

b 3 cells (50.0%) have expected count less than 5. The minimum expected count is .92.

			PMS for back office automation		Total
			No	Yes	
Rooms4	Efficient	Count	1	26	27
		Expected Count	3.115385	23.88462	27
		% within PMS.BACK	11.11111	37.68116	34.61538
		Std. Residual	-1.19849	0.432843	
	above	Count	6	21	27
		Expected Count	3.115385	23.88462	27
		% within PMS.BACK	66.66667	30.43478	34.61538
		Std. Residual	1.634301	-0.59024	
	below	Count	2	22	24
		Expected Count	2.769231	21.23077	24
		% within PMS.BACK	22.22222	31.88406	30.76923
		Std. Residual	-0.46225	0.166945	
Total		Count	9	69	78
		Expected Count	9	69	78
		% within PMS.BACK	100	100	100

Chi-Square Tests				
PMS		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	4.884595	2	0.086961
	Likelihood Ratio	4.863404	2	0.087887
	Linear-by-Linear Association	0.344427	1	0.557285
	N of Valid Cases	78		

b 3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.77.

			PMS for communicating		Total
			No	Yes	
Rooms4	Efficient	Count	10	17	27
		Expected Count	14.88462	12.11538	27
		% within PMS.COM	23.25581	48.57143	34.61538
		Std. Residual	-1.26608	1.403336	
	above	Count	20	7	27
		Expected Count	14.88462	12.11538	27
		% within PMS.COM	46.51163	20	34.61538
		Std. Residual	1.325896	-1.46964	
	below	Count	13	11	24
		Expected Count	13.23077	10.76923	24
		% within PMS.COM	30.23256	31.42857	30.76923
		Std. Residual	-0.06344	0.070321	
Total		Count	43	35	78
		Expected Count	43	35	78
		% within PMS.COM	100	100	100

Chi-Square Tests				
PMS		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	7.499114	2	0.023528
	Likelihood Ratio	7.707405	2	0.021201
	Linear-by-Linear Association	1.698581	1	0.192474
	N of Valid Cases	78		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.77.

			PMS for collecting and storing data		Total
			No	Yes	
Rooms4	Efficient	Count	3	24	27
		Expected Count	7.615385	19.38462	27
		% within PMS.COLL	13.63636	42.85714	34.61538
		Std. Residual	-1.67248	1.048285	
	above	Count	8	19	27
		Expected Count	7.615385	19.38462	27
		% within PMS.COLL	36.36364	33.92857	34.61538
		Std. Residual	0.139374	-0.08736	
	below	Count	11	13	24
		Expected Count	6.769231	17.23077	24
		% within PMS.COLL	50	23.21429	30.76923
		Std. Residual	1.626109	-1.01922	
Total		Count	22	56	78
		Expected Count	22	56	78
		% within PMS.COLL	100	100	100

Chi-Square Tests				
PMS		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	7.606196	2	0.022302
	Likelihood Ratio	8.044737	2	0.01791
	Linear-by-Linear Association	7.497166	1	0.00618
	N of Valid Cases	78		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.77.

			PMS for analysing data		Total
			No	Yes	
Rooms4	Efficient	Count	4	23	27
		Expected Count	9.346154	17.65385	27
		% within PMS.ANAL	14.81481	45.09804	34.61538
		Std. Residual	-1.74874	1.272395	
	above	Count	11	16	27
		Expected Count	9.346154	17.65385	27
		% within PMS.ANAL	40.74074	31.37255	34.61538
		Std. Residual	0.540977	-0.39362	
	below	Count	12	12	24
		Expected Count	8.307692	15.69231	24
		% within PMS.ANAL	44.44444	23.52941	30.76923
		Std. Residual	1.281025	-0.93208	
Total		Count	27	51	78
		Expected Count	27	51	78
		% within PMS.ANAL	100	100	100

PMS		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	7.634471	2	0.021989
	Likelihood Ratio	8.203349	2	0.016545
	Linear-by-Linear Association	7.002513	1	0.00814
	N of Valid Cases	78		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.31.

			PMS as an electronic platform		Total
			No	Yes	
Rooms4	Efficient	Count	6	21	27
		Expected Count	13.5	13.5	27
		% within PMS.PLAT	15.38462	53.84615	34.61538
		Std. Residual	-2.04124	2.041241	
	above	Count	18	9	27
		Expected Count	13.5	13.5	27
		% within PMS.PLAT	46.15385	23.07692	34.61538
		Std. Residual	1.224745	-1.22474	
	below	Count	15	9	24
		Expected Count	12	12	24
		% within PMS.PLAT	38.46154	23.07692	30.76923
		Std. Residual	0.866025	-0.86603	
Total		Count	39	39	78
		Expected Count	39	39	78
		% within PMS.PLAT	100	100	100

Chi-Square Tests

PMS		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	12.83333	2	0.001634
	Likelihood Ratio	13.40002	2	0.001231
	Linear-by-Linear Association	8.555556	1	0.003445
	N of Valid Cases	78		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.00.

Database and Rooms 3

			Database enable staff access use data		Total
			No	Yes	
Rooms3	Efficient	Count	4	11	15
		Expected Count	8.283582	6.716418	15
		% within DAT.ENAB	10.81081	36.66667	22.38806
		Std. Residual	-1.48833	1.652868	
	above	Count	15	9	24
		Expected Count	13.25373	10.74627	24
		% within DAT.ENAB	40.54054	30	35.8209
		Std. Residual	0.479669	-0.5327	
	below	Count	18	10	28
		Expected Count	15.46269	12.53731	28
		% within DAT.ENAB	48.64865	33.33333	41.79104
		Std. Residual	0.645255	-0.71659	
Total		Count	37	30	67
		Expected Count	37	30	67
		% within DAT.ENAB	100	100	100

Chi-Square Tests				
database		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	6.390797	2	0.04095
	Likelihood Ratio	6.498185	2	0.038809
	Linear-by-Linear Association	4.578926	1	0.032367
	N of Valid Cases	67		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.72.

			Database for front and/or back office automation		Total
			No	Yes	
Rooms3	Efficient	Count	4	11	15
		Expected Count	6.044776	8.955224	15
		% within DAT.FR.B	14.81481	27.5	22.38806
		Std. Residual	-0.83168	0.683294	
	above	Count	14	10	24
		Expected Count	9.671642	14.32836	24
		% within DAT.FR.B	51.85185	25	35.8209
		Std. Residual	1.391788	-1.14347	
	below	Count	9	19	28
		Expected Count	11.28358	16.71642	28
		% within DAT.FR.B	33.33333	47.5	41.79104
		Std. Residual	-0.67982	0.558528	
Total		Count	27	40	67
		Expected Count	27	40	67
		% within DAT.FR.B	100	100	100

Chi-Square Tests				
database		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	5.177286	2	0.075122
	Likelihood Ratio	5.179803	2	0.075027
	Linear-by-Linear Association	0.005769	1	0.939458
	N of Valid Cases	67		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.04.

			Database for automating marketing & sales		Total
			No	Yes	
Rooms3	Efficient	Count	3	12	15
		Expected Count	5.820896	9.179104	15
		% within DAT.MK.S	11.53846	29.26829	22.38806
		Std. Residual	-1.16921	0.93108	
	above	Count	11	13	24
		Expected Count	9.313433	14.68657	24
		% within DAT.MK.S	42.30769	31.70732	35.8209
		Std. Residual	0.552648	-0.44009	
	below	Count	12	16	28
		Expected Count	10.86567	17.13433	28
		% within DAT.MK.S	46.15385	39.02439	41.79104
		Std. Residual	0.34412	-0.27403	
Total		Count	26	41	67
		Expected Count	26	41	67
		% within DAT.MK.S	100	100	100

Chi-Square Tests				
database		Value	df	Asymp. Sig. (2-sided)
yes	Pearson Chi-Square	2.926574	2	0.231474
	Likelihood Ratio	3.13575	2	0.208488
	Linear-by-Linear Association	1.603204	1	0.20545
	N of Valid Cases	67		

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.82.

			Database for customising promotion and sales		Total
			No	Yes	
Rooms3	Efficient	Count	1	14	15
		Expected Count	3.58209	11.41791	15
		% within DAT.CUST	6.25	27.45098	22.38806
		Std. Residual	-1.36428	0.764149	
	above	Count	5	19	24
		Expected Count	5.731343	18.26866	24
		% within DAT.CUST	31.25	37.2549	35.8209
		Std. Residual	-0.30549	0.171107	
	below	Count	10	18	28
		Expected Count	6.686567	21.31343	28
		% within DAT.CUST	62.5	35.29412	41.79104
		Std. Residual	1.281376	-0.71771	
Total		Count	16	51	67
		Expected Count	16	51	67
		% within DAT.CUST	100	100	100

Chi-Square Tests				
database		**Value**	**df**	**Asymp. Sig. (2-sided)**
yes	Pearson Chi-Square	4.724818	2	0.094193
	Likelihood Ratio	5.249966	2	0.072441
	Linear-by-Linear Association	4.65327	1	0.030994
	N of Valid Cases	67		

b 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.58.

			Database for CRM		**Total**
			No	Yes	
Rooms3	**Efficient**	Count	5	10	15
		Expected Count	11.64179	3.358209	15
		% within DAT.CRM	9.615385	66.66667	22.38806
		Std. Residual	-1.94659	3.62436	
	above	Count	23	1	24
		Expected Count	18.62687	5.373134	24
		% within DAT.CRM	44.23077	6.666667	35.8209
		Std. Residual	1.013265	-1.8866	
	below	Count	24	4	28
		Expected Count	21.73134	6.268657	28
		% within DAT.CRM	46.15385	26.66667	41.79104
		Std. Residual	0.48666	-0.90611	
Total		Count	52	15	67
		Expected Count	52	15	67
		% within DAT.CRM	100	100	100

Chi-Square Tests				
database		**Value**	**df**	**Asymp. Sig. (2-sided)**
yes	Pearson Chi-Square	22.56904	2	1.26E-05
	Likelihood Ratio	20.88217	2	2.92E-05
	Linear-by-Linear Association	11.12009	1	0.000854
	N of Valid Cases	67		

b 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.36.

			Database for planning the hotel strategy		**Total**
			No	**Yes**	
Rooms3	**Efficient**	Count	7	8	15
		Expected Count	10.52239	4.477612	15
		% within DAT.STRA	14.89362	40	22.38806
		Std. Residual	-1.08588	1.664616	
	above	Count	23	1	24
		Expected Count	16.83582	7.164179	24
		% within DAT.STRA	48.93617	5	35.8209
		Std. Residual	1.502305	-2.30299	
	below	Count	17	11	28
		Expected Count	19.64179	8.358209	28
		% within DAT.STRA	36.17021	55	41.79104
		Std. Residual	-0.59608	0.91378	
Total		Count	47	20	67
		Expected Count	47	20	67
		% within DAT.STRA	100	100	100

Chi-Square Tests				
database		**Value**	**df**	**Asymp. Sig. (2-sided)**
yes	Pearson Chi-Square	12.70107	2	0.001746
	Likelihood Ratio	15.12359	2	0.00052
	Linear-by-Linear Association	0.090122	1	0.764022
	N of Valid Cases	67		

b 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.48.

Appendix G
Hotel ownership and management arrangement, ICT integration and sophistication of use and productivity

T-Test investigating the differences in ICT integration between independent and chain owned hotels

Descriptives					
	ownership	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
% of all ICT integrated with PMS (1)	independently owned	47	0.352648	0.296818	0.043295
	chained owned	43	0.638946	0.237299	0.036188
% of distribution ICT integrated with PMS (2)	independently owned	47	0.218085	0.255963	0.037336
	chained owned	45	0.584815	0.26697	0.039798
% of reservation ICT integrated with PMS (3)	independently owned	47	0.273987	0.318993	0.04653
	chained owned	45	0.606672	0.274352	0.040898
Percentage of FB ICT integrated with PMS (4)	independently owned	48	0.275678	0.240218	0.034672
	chained owned	45	0.387506	0.207412	0.030919

T -Test										
		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
1	Equal variances assumed	7.283073	0.008345	-5.02379	88	2.63E-06	-0.2863	0.056988	-0.39955	-0.17305
	Equal variances not assumed			-5.07375	86.49051	2.20E-06	-0.2863	0.056427	-0.39846	-0.17413
2	Equal variances assumed	0.000148	0.990309	-6.72664	90	1.56E-09	-0.36673	0.054519	-0.47504	-0.25842
	Equal variances not assumed			-6.72042	89.33923	1.64E-09	-0.36673	0.054569	-0.47515	-0.25831
3	Equal variances assumed	2.459488	0.120326	-5.35268	90	6.56E-07	-0.33269	0.062153	-0.45616	-0.20921
	Equal variances not assumed			-5.37031	88.998	6.21E-07	-0.33269	0.061949	-0.45578	-0.20959
4	Equal variances assumed	3.671355	0.058494	-2.39576	91	1.86E-02	-0.11183	0.046678	-0.20455	-0.01911
	Equal variances not assumed			-2.40718	90.40469	1.81E-02	-0.11183	0.046456	-0.20412	-0.01954

ANOVA test investigating differences in ICT integration among independent hotels (1), hotel chained hotels (3) and independent and consortia members hotels (2).

D escriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
% of all ICT integrated with PMS (1)	1	28	0.315748	0.26613	0.050294	0.212553	0.418943	0	0.888889
	2	45	0.610549	0.267364	0.039856	0.530224	0.690874	0	1
% of distribution ICT integrated with PMS (2)	3	17	0.454914	0.323624	0.07849	0.288522	0.621306	0	0.8
	Total	90	0.489435	0.304614	0.032109	0.425635	0.553235	0	1
% of reservation ICT integrated with PMS (3)	1	27	0.219753	0.232326	0.044711	0.127848	0.311658	0	0.666667
	2	47	0.559929	0.287074	0.041874	0.475641	0.644217	0	1
	3	18	0.239815	0.297711	0.070171	0.091766	0.387863	0	0.75
Percentage of FB ICT integrated with PMS (4)	Total	92	0.397464	0.318679	0.033225	0.331467	0.46346	0	1
% of all ICT integrated with PMS (1)	1	27	0.288448	0.301302	0.057986	0.169257	0.407639	0	1
	2	47	0.580856	0.295496	0.043102	0.494095	0.667617	0	1
% of distribution ICT integrated with PMS (2)	3	18	0.282738	0.356724	0.084081	0.105343	0.460133	0	0.833333
	Total	92	0.436713	0.340282	0.035477	0.366243	0.507184	0	1
% of reservation ICT integrated with PMS (3)	1	28	0.233876	0.225223	0.042563	0.146543	0.321208	0	0.727273
	2	47	0.39773	0.209235	0.03052	0.336296	0.459164	0	0.8
	3	18	0.301581	0.245327	0.057824	0.179583	0.423579	0	0.666667
	Total	93	0.329788	0.230676	0.02392	0.282281	0.377295	0	0.8

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
% of all ICT integrated with PMS (1)	1.463808	2	87	0.236995
% of distribution ICT integrated with PMS (2)	1.449478	2	89	0.240179
% of reservation ICT integrated with PMS (3)	1.446726	2	89	0.24082
% of FB integrated with PMS (4)	1.504932	2	90	0.227566

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
% of all ICT integrated with PMS (1)	Between Groups	1.525024	2	0.762512	9.852347	0.000139
	Within Groups	6.733275	87	0.077394		
	Total	8.258299	89			
% of distribution ICT integrated with PMS (2)	Between Groups	2.540611	2	1.270305	16.87164	6.13E-07
	Within Groups	6.70102	89	0.075292		
	Total	9.24163	91			
% of reservation ICT integrated with PMS (3)	Between Groups	1.996807	2	0.998404	10.40461	8.7E-05
	Within Groups	8.540244	89	0.095958		
	Total	10.53705	91			
% of FB ICT integrated with PMS (4)	Between Groups	0.488858	2	0.244429	4.992216	0.008789
	Within Groups	4.406582	90	0.048962		
	Total	4.89544	92			

Multiple Comparisons Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) MANAG	(J) MANAG				Lower Bound	Upper Bound
% of all ICT integrated with PMS (1)	1	2	-0.2948	0.066962	0.000159	-0.46157	-0.12803
		3	-0.13917	0.085537	0.271509	-0.3522	0.073865
	2	1	0.294801	0.066962	0.000159	0.128031	0.46157
		3	0.155635	0.079199	0.15119	-0.04161	0.35288
	3	1	0.139166	0.085537	0.271509	-0.07387	0.352197
		2	-0.15564	0.079199	0.15119	-0.35288	0.04161
% of distribution ICT integrated with PMS (2)	1	2	-0.34018	0.066261	9.71E-06	-0.50514	-0.17522
		3	-0.02006	0.083496	0.971556	-0.22793	0.187803
	2	1	0.340176	0.066261	9.71E-06	0.175217	0.505135
		3	0.320114	0.076058	0.00031	0.130765	0.509464
	3	1	0.020062	0.083496	0.971556	-0.1878	0.227926
		2	-0.32011	0.076058	0.00031	-0.50946	-0.13077
% of reservation ICT integrated with PMS (3)	1	2	-0.29241	0.074804	0.000867	-0.47863	-0.10618
		3	0.00571	0.09426	0.998167	-0.22895	0.240373
	2	1	0.292408	0.074804	0.000867	0.106182	0.478635
		3	0.298118	0.085864	0.003508	0.084357	0.511879
	3	1	-0.00571	0.09426	0.998167	-0.24037	0.228953
		2	-0.29812	0.085864	0.003508	-0.51188	-0.08436
% of FB ICT integrated with PMS (4)	1	2	-0.16385	0.052824	0.010351	-0.29534	-0.03237
		3	-0.06771	0.066849	0.6005	-0.2341	0.098685
	2	1	0.163855	0.052824	0.010351	0.032372	0.295337
		3	0.096149	0.061334	0.297522	-0.05651	0.248813
	3	1	0.067705	0.066849	0.6005	-0.09869	0.234095
		2	-0.09615	0.061334	0.297522	-0.24881	0.056514

* The mean difference is significant at the .05 level.

T-tests investigating differences in ICT sophistication between independent and hotel chain hotels

Descriptives					
	ownership	N	Mean	Std. Deviation	Std. Error Mean
PMS sophistication score	independently owned	48	6.8125	6.276116	0.905879
	chained owned	45	11.97778	6.510442	0.970519
WEB.SOPH	independently owned	48	5.75	4.674512	0.674708
	chained owned	45	7.711111	5.683398	0.847231
EML.SOPH	independently owned	48	6.104167	4.283762	0.618308
	chained owned	45	9.444444	5.097038	0.759822
INTR.SOP	independently owned	48	1.0625	3.198445	0.461656
	chained owned	45	4.177778	5.214878	0.777388
EXT.SOPH	independently owned	48	0.104167	0.721688	0.104167
	chained owned	45	0.533333	1.960983	0.292326
DAT.SOPH	independently owned	48	3.708333	3.803461	0.548982
	chained owned	45	7.4	6.853665	1.021684

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PMS sophistication score	Equal variances assumed	0.099638	0.752987	-3.89534	91	0.000187	-5.16528	1.326016	-7.79925	-2.53131
	Equal variances not assumed			-3.89068	90.06591	0.000191	-5.16528	1.327601	-7.80276	-2.52779
WEB.SOPH	Equal variances assumed	4.082835	0.04626	-1.82214	91	0.071719	-1.96111	1.07627	-4.09899	0.176767
	Equal variances not assumed			-1.8107	85.36418	0.073705	-1.96111	1.083065	-4.1144	0.192181
EML.SOPH	Equal variances assumed	2.595352	0.110641	-3.429	91	0.000912	-3.34028	0.974126	-5.27526	-1.4053
	Equal variances not assumed			-3.40981	86.18659	0.000991	-3.34028	0.979609	-5.28762	-1.39294
INTR.SOP	Equal variances assumed	25.36676	2.39E-06	-3.49692	91	0.00073	-3.11528	0.890863	-4.88487	-1.34569
	Equal variances not assumed			-3.44559	72.1107	0.000954	-3.11528	0.904134	-4.91759	-1.31297
EXT.SOPH	Equal variances assumed	8.353453	0.004813	-1.41772	91	0.159688	-0.42917	0.302716	-1.03047	0.172141
	Equal variances not assumed			-1.38293	55.05237	0.172269	-0.42917	0.310331	-1.05107	0.192737
DAT.SOPH	Equal variances assumed		22.94082	6.45E-06	-3.23833	91	0.001679	-3.69167	1.139989	-5.95612
	Equal variances not assumed			-3.18292	67.78561	0.002202	-3.69167	1.159836	-6.00622	-1.37712

ANOVA test investigating differences in ICT sophistication among independent hotels (1), hotel chain hotels (3) and independent & consortia members hotels (2)

Descriptives									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
PMS sophistication score	1	28	6.678571	5.862963	1.107996	4.405152	8.951991	0	18
	2	47	11.55319	6.684858	0.975087	9.590444	13.51594	0	18
	3	18	7.555556	7.13914	1.682711	4.005345	11.10577	0	18
	Total	93	9.311828	6.865127	0.71188	7.897972	10.72568	0	18
WEB.SOPH	1	28	5.857143	4.428145	0.836841	4.140088	7.574198	0	18
	2	47	7.425532	5.72464	0.835025	5.744715	9.106349	0	18
	3	18	6.111111	5.143687	1.212379	3.553216	8.669006	0	17
	Total	93	6.698925	5.251884	0.544595	5.617312	7.780537	0	18
EML.SOPH	1	28	6.785714	4.254472	0.80402	5.136002	8.435426	0	16
	2	47	9.170213	5.155492	0.752006	7.656504	10.68392	0	16
	3	18	5.388889	4.421058	1.042053	3.190349	7.587429	0	16
	Total	93	7.72043	4.961516	0.514485	6.698618	8.742242	0	16
INTR.SOP	1	28	0.5	1.478237	0.279361	-0.0732	1.073201	0	5
	2	47	4	5.170989	0.754266	2.481741	5.518259	0	19
	3	18	2.055556	4.807742	1.133196	-0.33528	4.446389	0	19
	Total	93	2.569892	4.547808	0.471586	1.633282	3.506503	0	19
EXT.SOPH	1	28	0	0	0	0	0	0	0
	2	47	0.510638	1.920964	0.280201	-0.05338	1.074654	0	10
	3	18	0.277778	1.178511	0.277778	-0.30828	0.863838	0	5
	Total	93	0.311828	1.46687	0.152107	0.00973	0.613926	0	10
DAT.SOPH	1	28	3.357143	2.984085	0.563939	2.200036	4.51425	0	9
	2	47	7.404255	6.703859	0.977858	5.435929	9.372582	0	18
	3	18	3.833333	4.889966	1.152576	1.401611	6.265056	0	17
	Total	93	5.494624	5.770283	0.59835	4.306248	6.682999	0	18

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
PMS sophistication score	Between Groups	485.7884	2	242.8942	5.677797	0.004762
	Within Groups	3850.169	90	42.77965		
	Total	4335.957	92			
WEB.SOPH	Between Groups	50.87418	2	25.43709	0.920635	0.401984
	Within Groups	2486.696	90	27.62995		
	Total	2537.57	92			
EML.SOPH	Between Groups	221.1008	2	110.5504	4.86856	0.009826
	Within Groups	2043.63	90	22.707		
	Total	2264.731	92			
INTR.SOP	Between Groups	220.8513	2	110.4256	5.90882	0.00388
	Within Groups	1681.944	90	18.68827		
	Total	1902.796	92			
EXT.SOPH	Between Groups	4.601197	2	2.300599	1.070844	0.347045
	Within Groups	193.3558	90	2.148398		
	Total	197.957	92			
DAT.SOPH	Between Groups	348.9996	2	174.4998	5.786127	0.004325
	Within Groups	2714.248	90	30.15831		
	Total	3063.247	92			

Multiple Comparisons Scheffe							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) MANAG	(J) MANAG				Lower Bound	Upper Bound
PMS sophistication score	1	2	-4.87462	1.561426	0.009785	-8.76109	-0.98815
		3	-0.87698	1.975979	0.906303	-5.7953	4.041336
	2	1	4.87462	1.561426	0.009785	0.988145	8.761095
		3	3.997636	1.812968	0.093699	-0.51494	8.510213
	3	1	0.876984	1.975979	0.906303	-4.04134	5.795304
		2	-3.99764	1.812968	0.093699	-8.51021	0.514941
EML.SOPH	1	2	-2.3845	1.137582	0.117079	-5.216	0.447005
		3	1.396825	1.439606	0.626078	-2.18643	4.980084
	2	1	2.384498	1.137582	0.117079	-0.44701	5.216002
		3	3.781324	1.320844	0.019804	0.493671	7.068977
	3	1	-1.39683	1.439606	0.626078	-4.98008	2.186433
		2	-3.78132	1.320844	0.019804	-7.06898	-0.49367
INTR.SOP	1	2	-3.5	1.032018	0.004463	-6.06875	-0.93125
		3	-1.55556	1.306015	0.494706	-4.8063	1.695188
	2	1	3.5	1.032018	0.004463	0.93125	6.06875
		3	1.944444	1.198274	0.273161	-1.03813	4.927014
	3	1	1.555556	1.306015	0.494706	-1.69519	4.806299
		2	-1.94444	1.198274	0.273161	-4.92701	1.038125
DAT.SOPH	1	2	-4.04711	1.311011	0.010791	-7.31029	-0.78393
		3	-0.47619	1.659079	0.959664	-4.60573	3.653349
	2	1	4.047112	1.311011	0.010791	0.783935	7.31029
		3	3.570922	1.522211	0.069202	-0.21795	7.35979
	3	1	0.47619	1.659079	0.959664	-3.65335	4.60573
		2	-3.57092	1.522211	0.069202	-7.35979	0.217946

* The mean difference is significant at the .05 level.