Lancaster University

School of Management

Management Science Department

An Assessment of Operating Performance in Contract Managed Hospitals Versus Traditionally Managed Hospitals:

A Case Study of Ministry of Health Hospitals in Saudi Arabia

By

Ahmed Al Shaikh

(Bsc. In Operation Management, MBA in Operations Analysis)

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Bell & Howell Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
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Ph.D. Thesis
Department of Management Science

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Abstract

Public Hospitals in Saudi Arabia in general and Ministry of Health (MOH) hospitals in particular are under dual pressures in two directions. In one direction the general public is demanding high quality services in all hospitals. In the opposite direction government is imposing strict rules to constrain government spending to limit the deficit on the government's annual budget caused by the drop in the oil prices which started in early eighties. Contract Management (CM) was introduced in Saudi Arabia in the late 1970's to improve the operating capabilities of the hospitals. However increases in operating costs induced by contract management has raised a very important question in Saudi Arabia, namely- what is the impact of contract management on the performance of hospitals ?

The primary purpose of this research is to evaluate the performance of the Saudi Arabian Ministry of Health hospitals under the three types of management:

- Self Management
- Comprehensive Contract Management
- Full Service Contract Management

A second major purpose of the research is to improve understanding of the differences in hospitals' performance, and to explore the impact of the types of management and other hospital characteristics on performance; e.g. size and demographic issues. Understanding these relationships will have policy consequences for resource allocation, efficiency and quality in the delivery of hospital care. However there were a number of important issues addressed. First, a general framework for performance evaluation and the more specific issue of contract management was required. Second the existence of diverse perspectives on hospital performance measurement and evaluation provided an important challenge for this study.

This research involves three main phases. The first phase is literature based (chapters 2 and 3). The second phase is a more detailed study of CM in 75 Ministry of Health hospitals in Saudi Arabia. The approach is pragmatic and practical in that it seeks to make use of available information to inform policy making. As such it is intended that results will be relevant to policy making. The second phase uses a variety of quantitative approaches to analyse the available data, and is described in chapters 4 to 7. The third phase (chapter 8) is more reflective. It summarises and discusses the earlier results, and identifies their main policy recommendations. However it also reflects on the strengths and weaknesses of the study.

Phase 1

This research evaluates contract management using a broad perspective. After providing an overview of the conceptual framework for assessing performance, three main dimensions of hospital performance derived from a goal attainment perspective are specified (operating efficiency, quality of care and organizational structure).

Performance indicators are then identified reflecting these three dimensions, utilizing available quantitative and qualitative data.

The experiences in other health systems, specifically the US and the UK (NHS), are important in this respect, and hence have been reviewed. The motives for the Saudi MOH to use CM have much in common with the motives described in several studies conducted in the USA; and the conceptual framework for this research derives from this.

Phase 2

The second phase uses a variety of quantitative approaches. A series of statistical approaches, including analysis of variance and factor analysis, have been used (chapter 5) on the performance indicators to investigate the extent to which the three dimensions of hospital performance can be explained by type of management and / or other factors.

However, a particular feature of this work is the need to analyze multiple inputs and multiple outputs simultaneously This is a situation for which Data Envelopment Analysis (DEA) has been specifically designed. Hence DEA is used in chapter 6 to estimate the relative technical efficiency scores of the hospitals. Special software designed for DEA called " Frontier Analyst" is used. A number of theoretical and practical concerns about the application of DEA lead to a range of DEA models being examined and compared. Two sets of DEA efficiency scores are then calculated for the hospitals, one of which calculates efficiency relative to the whole group, the other calculates efficiency allowing for scale effects.

In contrast to most of the DEA literature, this research utilized DEA not only to estimate the efficiency scores and to identify peers etc. within the defined DEA framework, but it also employed the DEA efficiency scores in number of post hoc analyses. The effects of type of management and / or other factors on efficiency are examined.

The relationships between DEA efficiency scores and the earlier performance indicators are investigated in chapter 7. They shed light on, and provide evidence of, the efficiency classification made by DEA, and provide an insights into determinants of efficiency. Exploring the relationships between efficiency and hospital performance in terms of operation, quality of care and organizational structure provides practical guidance for policy makers; and helps hospital managers to recognise efficiency problems in terms of traditional performance indicators. This chapter also highlights and demonstrates how the two methods of analysis (DEA and statistical) can complement each other in real applications.

Phase 3

Results of this research have a range of implications for the MOH policy makers and for hospital management. The results imply that CM has a positive impact on quality of care and services provided. CM also has a positive impact on organizational structure. However it has a negative impact on efficiency.

This final phase also reflects on the strengths and weaknesses of the case study. In particular it addresses the issue of the extent to which available data is adequate for evaluating policy options.

The research also has a methodological contribution. It has shown that DEA and traditional statistical techniques can, and perhaps should, be used together in a supportive way. Using them in parallel is more informative than using either separately, and will perhaps improve the extent to which management are able to make use of them in policy making and decision making.

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Chapter One: Introduction

This research concerns the assessment of the operating performance of hospitals in Saudi Arabia under different forms of contract management. To understand the performance of the hospitals and their determinants requires an understanding of the overall environment of which the hospitals are part of. This includes the population being served, its health, the structure of the overall healthcare system, and the hospitals' management environment. This chapter is organized as follows. First an overview of health and health system in Saudi Arabia is provided, then the Ministry of Health responsibilities and the channels for providing services are described. Next the importance of the study, its purpose and the nature of the problem being studied are discussed. Finally the organization of the thesis is presented.

1.1 Health and the Health System in Saudi Arabia

The Government of Saudi Arabia plays a major role in the health sector in Saudi Arabia, operating over 80% of primary health facilities and hospitals. The health sector has achieved enormous development since the late 1970's. It has experienced multiple expansions (vertically and horizontally) as a result of implementing comprehensive and ambitious development plans conducted by the Saudi Government. These plans had emphasized the development of basic infrastructure and public services.

The Government is committed to maintaining public health and providing health care to all citizens free of charge. This obligation by the government is part of its responsibilities that are stated in the Government's Principal Bylaws, which were declared in February 1992 (Articles 27 and 31). However although the Bylaws were only formally declared in a written constitutional form recently, they reflect the Saudi government's commitments to its citizens since the foundation of the Kingdom of Saudi Arabia in 1932. Free of charge health care and education are essential public services provided by the government under such rules. Therefore the Saudi health care system is predominantly publicly financed with public sector accounting for about 80% of total health care consumption. Centralization is also a major characteristic of the system.

The government is the major provider and controller of the industry, and has established a network of health care centers and hospitals scattered all over the country. At the same time it encouraged the private sector to participate in the development of the health care industry by encouraging investments in health care in a number of ways. In particular it granted interest free long-term loans to health care projects. This role conforms to the government policy of increasing the private sector participation in the economic and social development in the country.

The government, since the inception of the first development plan in 1970 till present time, paid special attention to the development of the health sector, aiming to enhance its contribution to the welfare and living standards of Saudi society. As stated in the development plans (MOH Department of Planning), the main objectives of the health care sector are:

- Raising of health standards of society and provision of preventive, therapeutic and rehabilitative care for all citizens at the highest level of expertise.
- Greater emphasis on control of infectious diseases with a view to reducing

the incidence rates to the lowest possible level and the eradication of a number of them.

- Expansion and improvement of primary health care programmes, concentrating on health care activities related to mother and child, and working for full immunization coverage against the infectious diseases for all children.
- Consolidation of the referral system, which aims to create an integrated health service, while providing high quality treatment.

Health care providers in Saudi Arabia can be divided into six groups:

1. Ministry of Health (MOH) provides free of charge health care including medicines to all Saudi Citizens and residents.
2. Specialty Hospitals affiliated with MOH (King Faisal Specialty Hospital and King Khalid Eye Specialty Hospital). They provide tertiary care for all Citizens free of charge if referred by MOH, and apply minimal fees for patients directly accessing the hospital.
3. University Hospitals provide free of charge health care for their staff, staff dependents, students and the public.
4. Other Government Agency hospitals and clinics e.g. Military, National Guard and Internal forces provide free of charge health care for their staff and staff dependants. Also with some limitations, they provide free of charge tertiary care for the public in some medical specialties: e.g. heart and liver transplantation.
5. Government Corporations (e.g. Social Insurance Agency, ARAMCO and Royal Commission for Jubail and Yanbu Industrial Cities) provide free of

charge health care for their staff and staff dependents. Except ARAMCO, they also provide fee-for- service health care for the public in a manner that is similar to the private hospital practice.

6. Private hospitals and clinics provide fee-for-service health care to all residents in the country.

However the scope of population coverage by the Ministry of Health is in the process of change with the implementation of the new health care rules that have led to the emergence of health care insurance as an alternative that will be applied to Non-Saudi residents as a first phase. The new rules are due to be put into action early year 2001. Details of the features and expected impacts of such a change on the health sector are yet to be evaluated

Table 1.1 shows the distribution of health facilities among health care providers in Saudi Arabia. Public sector involvement in health care as indicated by the number of bed accounts for a little over 80% of the existing beds. The MOH is the largest single health care provider, operating about 74% of the health care centers, providing about 63% of the available beds, and providing about 51% of the medical staff. The Private Sector is the second largest health care provider, with 26% of the health care centers and 16% of the beds.

Provider	Beds		Health Centers	%	Medical Staff*	%
MOH	26692	63	1731	74	15206	51
Specialty Hospitals	812	.9	-		596	2
Universities	1439	.4	-		1114	3.7
Other Government Agencies	5509	2.9	-		3726	12.5
Government Corporations	1297		-		800	2.7
Private Sector	6876	6	598	6	8482	28.3
Total	42625		2329		30544	

Table 1.1: Health Care Facilities by Provider -Source: Ministry of Health Annual Report (199)
***Includes medical staff in the Health care clinics**

In terms of the share of the health sector in the national economy measured by the proportion of gross domestic product (GDP), the Saudi Arabian health sector accounted for 2.2% during the period 1990 – 1995. This percentage seems to be low in comparison with world average of 5.0%, USA average of 14.3%, UK average of 6.9% and France and Germany averages of 9.5% and 9.7% of GDP respectively[1].

On the other hand availability of health care and health services in Saudi Arabia is considered high compared to the world average. As shown in table 1.2, the percentage of the citizens having health care was 98% of the total population in 1993. There were only 22 countries with the rate of 100%, and 15 with rates ranging between 90%-99%. On other indicators Saudi Arabian Citizens having safe water were 93% in 1994-1995, child immunization against measles reached 94% in 1995, and child immunization with triple vaccine was 97% in 1995.

		Saudi Arabia	World Ave.
1	Citizens having health care in 1993 (% of total population)	98	79
2	Citizens having safe water in 1994-1995 (% of total population)	93	76
3	Children immunized against measles in 1995	94	80
4	Children immunized with triple vaccine in 1995	97	82

Table 1.2: Health care and Health Services availability -Source of statistics: World Bank 1997

Quality of life as measured by the life expectancy and the rate of child and adult mortality in the World Bank report on world development in 1997 (table 1.3) indicates that quality of life in Saudi Arabia is better than the World average. However, better than the world average still leaves plenty of scope for improvement. For example, 30% of the world's countries have infant mortality rates lower than the rates in the Kingdom, with 20 countries having rates below 10 deaths per 1000 live births. Among those are Canada, Sweden, UK, USA, Holland, Belgium, Ireland, Hong Kong, Australia, Austria, Finland, France, Germany, Singapore and Cuba.

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1 Source of statistics is the World Development indicators: World Bank 1997.

	Saudi Arabia	World Ave.
Life Expectancy at birth for Males (Years)	69	65
Life Expectancy at birth for Females (Years)	71	69
Infant mortality rate (Deaths per 1000 live births)	21	55
Children under 5 years Mortality (Deaths per 1000 live births)	31	81
Adult Males mortality (Deaths per 1000 population)	181	222
Adult Female mortality (Deaths per 1000 population)	149	164

Table 1.3 Quality of life Statistics -Source of statistics: World Bank 1997

1.2 Overview of the Ministry of Health

The Ministry of Health is the main authority responsible for providing healthcare to all Saudi citizens. It provides 70-75% of the healthcare in the Kingdom through a network of primary healthcare centers (1,731) and secondary and tertiary care hospitals (173), accounting for 63% of the total beds in the country. The MOH is responsible for the general and overall health policies. The role of MOH, as the main player in the health sector can be summarized as follows[2]:

- Developing and implementing the government health policies and plans.
- Providing free of charge health care (preventive, curative and rehabilitative) for the population of the kingdom at the three levels of care (primary, secondary and tertiary). Through establishing and operating (directly or indirectly) the public health facilities (hospitals, primary health care centers, disease prevention programs and laboratories and blood banks) and providing required medicines, medical technology and

2 Source: MOH Department of Planning.

supplies.

- Preventing and controlling infectious diseases in the country.
- Providing and monitoring health information.
- Regulating and licensing the private sector health activities; e.g. hospitals, health centers and clinics and medicine production, importation and sales.
- Representing the country in international organizations and conferences.
- Providing health care to Pilgrims visiting the two holy cities.
- Investigating and resolving medical malpractice complaints and medical legal cases.

To shed more light on MOH roles and responsibilities for general health policies, the major features of the health policies can be summarized as follows[3]:

1. To improve the health condition of the population, in particular eradication of epidemic diseases.
2. To provide each region's population with a fully integrated and comprehensive system of free of charge medical care services through MOH.
3. To improve the standards of health care and the efficiency of health services administration.
4. To increase the number of medical personnel and improve quality, particularly by encouraging more Saudis to specialize in medical fields.
5. To establish a National Health Council to determine health policy, guide the development and improvement of all health services and delineate the

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3 Source: MOH Department of Planning.

responsibilities of health care agencies (government and private) and coordinate their different activities.

6. To encourage the private sector in expanding their medical services for citizens and foreign residents in the Kingdom.
7. To expand significantly a broad range of preventive health measures, including vaccination, environmental health, health education and mother and child programs.
8. To gain a thorough understanding of prevailing health conditions and medical services prior to starting a major health care expansion.
9. To increase the number of beds in the MOH hospitals through new construction and expansion of existing facilities
10. To increase specialized medical services in all central hospitals in the cities, and expand psychiatric and dental sections for outpatient treatment.
11. To improve and expand ambulance services, patient transportation and mobile medical services to increase geographical coverage.
12. To expand and upgrade the efficiency of engineering, maintenance and support and supply units in each region.
13. To promote and improve the proper use of drugs and medical supplies by introducing appropriate specifications and procedures for dispensing of drugs.
14. To implement a medical records system for all patients.

As shown in tables 1.4 and 1.5, the MOH provides its services through a three-tier institutional system of general hospitals, specialized hospitals (Maternity, Pediatric, psychiatric, chest and fever and convalescence & leprosy) and primary health care centres, supported by a network of regional laboratories and blood banks. However the MOH health care delivery system is dominated largely by the hospital sector, with hospitals utilizing over 70% of the health care personnel (medical staff, nursing and allied health staff). This is consistent with many developed countries where hospital cost has been the fastest growing component of health care expenditure in the last two decades, and hospitals consume the largest portion of their national health spending (Sochalski et al 1997; Hindle et al 1993).

Type of Facility	Count	Beds
General Hospitals	128	18940
Other Hospitals	47	7752
Health Centers	1731	NA
Central Laboratories and Blood Banks	5	NA

Table 1.4: MOH Facilities - Source: MOH Annual Report 1996
- NA: Not- Applicable

Type of Facility	Physicians	Nurses	Allied Health	Others	Total
Hospitals	10439	25369	12955	25914	74677
PHC	4172	8885	4520	14293	31870

Table 1.5: MOH Staff by type of Facility -Source: MOH Annual Report 1996

Having been working in the system it is the research's views that, as with other public sector agencies in the country, the organization of the MOH affects the extent to which it is able to achieve its objectives, and way it attempts to do so. For example:

1. The MOH is strongly centralized; rules are executed at the provincial and

hospital level under a hierarchical set of formal authorizations and controls.

2. Governing regulations that rule the internal organization of the health care facilities: e.g. hospitals and health care centres, do not cope with the nature of the operational needs of these facilities. They reflect an authoritarian system.
3. The organizational spending does not support the concern for a more cost-conscious management of the available resources. In fact the current methods of allocation of resources from the central authority to the health care units has not provided an explicit and objective financial constraint against which operational efficiency principles can be considered. The current system is a cost-based retrospective reimbursement system that only requires advanced authority approval and availability of funds.
4. The system lacks the mechanism for complete budget appraisal and expenditure evaluation.
5. The system lacks the incentives for efficient performance: i.e. savings in expenditure are not awarded to the units which achieve them.

In this context 'Contract Management' has been implemented by the MOH to try to over come some of these administrative and operational problems at the hospital level, and enhance the operational capabilities of its hospitals.

1.3 Contract Management in Saudi Arabian Hospitals

Until the late seventies, the Ministry of Health used internal operational resources to manage and operate its hospitals in a very traditional way. Hospital staff were recruited directly by the MOH. All administrative and operational activities were undertaken by the MOH staff.

However, by the late 1970's, the MOH had commenced an immense expansion in the health care facilities that was characterized by an increase in the construction of hospitals. In 1979 the construction of five new hospitals (500 beds each) completed and they became ready for operation. At the time the MOH lacked the required staff to operate these hospitals and lengthy financial and administrative procedures would have been needed to secure the staff with the qualifications to match the technology level established in these hospitals. The Ministry was therefore forced to consider and experiment with a number of alternatives to cope with the situation.

Starting with self-operation, the MOH utilized in-house resources for administration and medical operation, supported by the private sector through partial contracts for housekeeping and maintenance, catering and biomedical engineering.

The Ministry of Health then applied the partial contracts principle whereby each hospital or group of hospitals had a partial contract for each major element of the hospital operation (medical operation; housekeeping and maintenance; catering; biomedical engineering) and the Ministry of Health retained full supervision and administrative responsibilities, and part of the medical staff recruitment.

A number of administrative and contractual problems resulted from the number of contracts and contractors in each hospital, most important were related to the accountability and responsibility between the contractors. Secondary problems were related to the amount of paper work under each contract for each hospital. The MOH therefore adopted a unified contracts policy (Comprehensive Contracts) whereby partial contracts are unified in one contract and the one contractor is supported by subcontractors, as needed. The MOH retains the administration and supervision. In fact, this concept had a very positive impact, particularly on administration. Since the responsibility and liability were unified, communication and coordination were improved and a great reduction in the administrative and financial documentation was achieved in the hospitals.

In addition, the Ministry of Health also adopted the full service/turnkey contracts in some of the new hospitals. This type of contract implies that the contractor will be fully responsible for management and operation of the hospital under the supervision of a ministry representative who monitors the execution of the contract according to terms and conditions and technical specifications.

All hospital management and operation alternatives mentioned above were consistent with the overall strategies of the National Comprehensive Development plans which stipulated expansion of private sector opportunities to manage and operate the public facilities. For example, strategies in the fourth development plan (1985 – 1990) included measures for increasing private sector participation in the economy[4]:

- To increase opportunities for the private sector to acquire, manage and operate projects currently operated by the Government, providing that this will result in lower cost.
- To encourage greater participation of the private sector in the financing of development.
- To encourage and facilitate private sector investment in new areas, and

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4 Ministry of Planning 1985

encourage banks to facilitate financial support for productive projects.

However, public hospitals in Saudi Arabia in general and Ministry of Health hospitals in particular are under dual pressure in two directions. In one direction the general public is demanding high quality services in all hospitals. While, in the opposite direction, government is imposing strict rules to constrain government spending in order to limit the deficit on the government's annual budget caused by the drop in the oil prices which started in early eighties.

The MOH adopted the contract management policy at a time when the focus was on developing the capabilities to deliver health care to the citizens. Now that the health objectives have been achieved and the facilities required for delivering health care have been built, the emphasis has shifted to operational issues and the MOH has become increasingly concerned with improving the performance of its health delivery system.

The findings of a study conducted for the MOH by the Consulting Center for Finance and Investment[5], support the notion that the private sector is more effective and efficient in managing their hospitals than the public sector. This was attributed to the flexibility in the recruitment, purchasing, and financial procedures in addition to the more developed management methods and technologies used by the private sector. Despite these findings the MOH is still concerned because contract management has created additional costs for the MOH in operating its hospitals during a time when the MOH is facing budget constraints. According to the MOH (unpublished information) the average daily operational cost per bed under full service contracts is estimated to be approximately three times the cost in traditionally managed hospitals. This

5 Source: A study conducted by the consulting Center for Finance and Investment- a private firm – for MOH in 1987. The study purpose was to evaluate the feasibility of privatising MOH hospitals.

additional cost has used financial resources that might otherwise be available to traditionally managed hospitals and other health activities, and clashes with the Ministry of Health interests in cost containment and better utilization of available resources.

Having adopted contract management policies for more than 10 years, it is time for the Ministry of Health to evaluate its experience and decide whether it should continue, modify or curtail its contract management policies.

1.4 Purpose of the Research

This study is concerned with enhancing the understanding of contract management and performance in Saudi Arabian hospitals, through providing greater insight into the relationship between the forms of hospital management and hospital performance. No study in Saudi Arabia has empirically addressed the impact of contract management on the performance of hospitals. This study seeks to evaluate contract management using a broad perspective and looks at the operating performance differences between the contract managed hospitals and traditionally managed hospitals.

The primary purpose of this study is to evaluate the performance of the Saudi Arabian Ministry of Health hospitals under the three types of management (full service contracts, comprehensive contracts and traditional) applied by the Ministry to manage and operate its hospitals. A second major purpose is to help explain the differences in hospital performance and explore the impact of the types of management and other hospital characteristics likely to affect performance, e.g. bed size and demographic issues. Understanding these factors' relationships with hospital performance will have policy consequences for resource allocation, efficiency and effectiveness in the delivery of hospital care and will provide policy makers with useful insights for future decisions.

However, there are a number of important issues that need to be addressed with respect to this research context. First, a general framework for performance evaluation and the more specific issue of analyzing hospital contract management is required. The existence of diverse perspectives on hospital performance measurement and evaluation provide an important challenge for this study.

A second concern is the specific issue of how hospital performance is affected by type of management. The specific objectives arising from this concern are:

1. To examine the forms of management in Ministry of Health hospitals, to explore the problems associated with each of them, and to explore experiences in other health systems, specifically the US and the UK (NHS).
2. To compare the operational performance of Ministry of Health hospitals under contract management and under traditional management.
3. To suggest practical recommendations for the management of the Saudi Ministry of Health hospitals.

In addition the more general anticipated contributions of this research are:

1. Development of a conceptual framework linking hospital performance to type of management based on the conceptual underpinnings of major perspectives of both, drawing upon the performance theory and contract management literatures.
2. Development of empirically based models of the linkage between hospital performance and contract management.
3. Improved understanding of how alternative analytic approaches can be

used in combinations to assess organizational performance.

1.5 Organization of the Thesis

The remainder of this thesis is organized in 7 chapters.

Chapter 2 provides a comprehensive review of hospital performance. The body of literature discussed provides insights into definitions of hospital performance, its dimensions (e.g. effectiveness, efficiency and organizational structure), and its measurement.

Chapter 3 provides a comprehensive review of hospital contract management. Different perspectives on hospital contract management are analyzed, reflecting experiences in the USA, the UK and Saudi Arabia. This literature provides insights into motives for entering into hospital contract management, and the likely impacts and effects of contract management on hospital performance.

Chapter 4 describes the data sets and the methodologies used in the empirical phases of this research, including a discussion of the issue of case mix adjustment.

Chapter 5 addresses the specific objectives of this research using a range of statistical methods including ratio analysis, regression, factor analysis and discriminant analysis.

Chapter 6 then describes and applies an alternative method of analysis, Data Envelopment Analysis (DEA), to address the same questions. Previous applications of DEA are reviewed to guide this analysis.

Having looked at the advantages and the limitations of the statistical methods and DEA in the previous chapters, chapter 7 aims to combine the two alternative approaches and to show how the two can be used in tandem to inform hospital managers and health care policy makers about the effect of different types of hospital management.

Chapter 8 is devoted to the general discussion of the research results, and includes a summary of the research findings and conclusions, policy implications, methodological contributions and suggestions for future research.

Chapter Two: Hospital Performance

The focus of this research is concerned with whether forms of contract management have identifiable effects on the performance of hospitals. To properly address this issue it is important to first investigate and clarify the concept of hospital performance. This chapter therefore starts by providing a general introduction to the concept of hospital performance and then goes on to provide an overview of the main dimensions of hospital performance.

The three particular dimensions selected as being appropriate for this research are then each described in detail.

Available information thought to provide measures of hospital performance are often referred to as 'performance indicators'. In the final section of this chapter, important issues associated with using performance indicators are described before the performance indicators to be used in this research are outlined.

2.1 Concept of Hospital Performance

Hospital performance is relatively new concept, whereas hospitals have long been viewed as humanitarian organizations that provided a needed service (Christman and Counte 1981). They argue that rising consumerism, increased media coverage of health care, general economic inflation, growing governmental regulation of health care and the general trend in society toward adversarial relationships have only recently placed hospitals in a position similar to that of public utilities. In the UK the attention in the eighties was centered on the notion of performance review coupled with strict financial controls on resource input, where sets of performance indicators were developed toward the search for value for money and accountability (Klein 1982; Harrison 1997). However the new NHS reform plan (1998)[6], places more emphasis on efficiency along with quality as part of a broader set of performance measures, where the assessment will include the cost and results.

In the USA emphases on performance assessment shifted from quality of care and access to it for underserved populations such as the aged and the poor, as prevailed in the 1970's, toward more general efficiency and quality (Scott and Flood 1987). Prospective payment and capitation systems such as DRGs, increasing pressure to contain costs, and increasing competition drove this change in performance perspective. The Omnibus budget Reconciliation act of 1981 in the US stated that, " *a State Medicaid Program must provide a payment rate for inpatient hospital services that is reasonable and adequate to meet the costs which must be incurred by efficiently and economically operated facilities in order to provide care in conformity with applicable state and federal laws, regulations and quality and safety standards and to insure that individuals eligible for medical assistance have reasonable access to inpatient hospital services of adequate quality*". However "*efficiently and economically operated facilities*" were not defined in this legislation.

Hospital performance as well as health services performance in general, can be defined in different ways, with varying emphases. Some argue that only the result or outcome of health care is included in the concept of performance. Others consider the process, particularly the efficiency of the process.

However, the term performance as it has been used in the literature often has a broader and more comprehensive meaning. It includes the resources used to produce

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6 Source: NHS (1998) "The New NHS: Modern. Dependable". Paper published by NHS 1998.

the services (structure), the production and delivery of services and the services themselves (process), and their impact or outcome. Hence assessment of the performance of health services can be approached in a number of ways, reflecting concerns with one or a combination of these aspects.

Long and Harrison (1985) in an overview of health services performance highlighted a number of issues concerning its evaluation, which were summarized as follows:

- *"The performance of a health service must be viewed in relation to its effectiveness, its efficiency, and its acceptability".*
- *"The need for good information systems, as well as knowledge of the link between the input of health services and output in terms of health status outcomes".*
- *"The varying perspectives of the actors in health service (Funders, Practitioners and Consumers) in relation to performance".*

Different interest groups in a health service have different priorities for what they expect from the health service. Funders or payers whether government or for-profit organizations such as health insurance businesses favour efficiency, whereas recipients of the health service may favour quality and outcome, while physicians may favour up-to-date technology.

2.2 Dimensions of Hospital Performance in General

Variations in the perspective of evaluating health services organizations' performance have led to variations in the dimensions of performance among researchers. Different frameworks for analyzing health services organizations' performance are presented in the literature, reflecting conceptual and measurement differences. Scott and Shortell (1983) discussed conceptual and measurement factors, which need to be considered in defining and assessing organizational performance. They believe that both types of factors are important, but the conceptual ones are more important. As they have stated " *the most interesting questions in this area are not technical, they are conceptual: not how to measure effectiveness and productivity, but what to measure and why organizational performance is being measured*". Hence measurement of performance differs depending upon the purpose, for example to meet regulatory requirements or to take internal policy action. They believe that the conceptual performance issues are difficult because they are linked to central controversies regarding the purpose and nature of the organization. How the organizations are conceived determines the perspective for their performance assessment.

Goal attainment (the ability of the organization to reach its goals and objectives) is one perspective. Examples of such goals are: inpatient and outpatient care delivery, prevention, teaching, research and participation in the public health activities (Grant 1973; Scott and Flood 1987), and effectiveness, efficiency, equity, outcome achievement and profit making (Becker and Neuhauser 1975; Aday et al 1993; Goss 1970). Another perspective is system maintenance where attention is diverted toward the survival of the organization. Examples of system maintenance requirements are its ability for adaptation, integration, stability, morale, public image and customer satisfaction (Becker and Neuhauser 1975). A third perspective views organizations as open systems interdependent with their environments. In this case an organization's growth is directly dependent on its bargaining position with the environment, in terms of its ability to acquire scarce resources and its capacity to adapt to changes in the environment (Flood et al 1997).

Flood et al (1997) see that the most important issue in measuring organizational performance as related to the view of the fundamental purpose and nature of the organization, because this view affects the most critical assessment questions: what will be measured and why it is being evaluated? Therefore selecting an approach to hospital performance assessment requires the selection of assessment perspective.

In this thesis hospital performance will be assessed from a goal attainment perspective, because hospitals are conceived as rationally designed instruments for the production of goods and services for external consumption. Their main common goals concern patient care, whereas the system maintenance and open system perspectives may differ between hospitals according to their internal organizational needs and the differences in their environments. The definition of hospital goals and objectives is typically approached in one of two ways (Berki 1972). In the first approach a hospital is viewed like any other economically productive unit that exists to maximize profit, utility, cash flow or net revenue. In the second approach goals and objectives are related to factors other than profit, typically quantity and quality of hospital care.

Goss (1970) argues that the fundamental goal that is commonly shared by all hospitals and that distinguishes hospitals from other types of formal organizations – e.g. schools and businesses- is the provision of medical services aimed at cure, amelioration and prevention of disease in individuals. Johnson (1981) sees that the unique purpose of the hospital is to provide clinical services to patients as directed by physicians. While there is no clear consensus in the literature on appropriate hospital goals and objectives, quantity in terms of services provided and quality enter into the hospital's set of goals (Berki 1972)

Roos et al (1974) argue that there are official and operative goals for hospitals.

From their perspective, official goals represent general organizational purposes, which may be stated as " the provision of general health services to the community". Operative goals are those ends reflected in daily operating decisions and policies, and are evidenced by the resource commitment to certain facilities and activities. The most cited operating goals, according to Roos et al (1974) are:

- *Delivering care efficiently and economically;*
- *Improving access to care for the disadvantaged sections of population;*
- *Improving or maintaining the quality of care.*

The literature (Becker and Neuhauser 1975; Vuori 1982; Long and Harrison 1985; Sanderson 1987; Flood and Scott 1987; Flood et al 1997; Aday et al 1993; JCAHO1995; DHEW 1979; Li and Benton 1996) identifies varied and diverse dimensions of performance for health services organizations, including: effectiveness, efficiency, efficacy, equity, quality, productivity, continuity, accessibility, acceptability, availability, safety and timeliness. However these dimensions are interrelated and sometimes used interchangeably. Definitions and overlapping measures also indicate similarities between some of them. For example effectiveness and quality of care on one hand, and efficiency and productivity on the other hand have been used interchangeably in the literature.

Using the Roos et al (1974) operating goals perspectives, these dimensions can be grouped as environmental dimensions (i.e. efficacy; equity; continuity; accessibility; acceptability and availability) and inter-organizational dimensions (i.e. effectiveness and efficiency). By design the aim of contract management concerns the improvement of hospitals' operational inter-organizational performance capabilities. Although the MOH also has wider responsibilities related to the environmental dimensions, these are mainly beyond the scope of the contracts, and are therefore only referred to in passing in this research.

Making a similar point, Shortell et al (1976) argue that hospital efficiency and effectiveness can each be viewed as a function of a hospital's external environment, technology and certain internal organizational design variables. They further argue that a hospital has little control in the short term over its external environment or technology, but can exert considerable control over the internal design variables.

The dimensions related to hospital operational performance, i.e. effectiveness and efficiency have therefore been selected as the main focus of this research.

In addition, as reported by Flood et al (1982), several studies have suggested the relevance of several organizational structure variables to hospital performance. Some of these variables, which are suggested as leading to good performance, are therefore also included as possible indirect indicators of performance.

2.3 Effectiveness and Quality of care

Effectiveness has been defined in the literature as " the degree to which goals and objectives are successfully met" (Scott and Shortell 1983). This defines effectiveness in light of the goals and objectives of the organization. Luft (1980), and Flood and Scott (1987c) argue that the goal of medical care for a given patient is the maintenance or improvement of one's health rather than the consumption of medical services. According to this goal the amount of health and health improvement rather than the amount of services rendered should measure effectiveness. Aday et al (1993) view effectiveness of health services in terms of the benefits of medical care measured by improvements in health.

Holland (1983), from an epidemiological point of view, defines effectiveness as a measure of the degree to which a particular treatment or pattern of care in the population achieves its objective in medical, psychological and social terms. He differentiates between four aspects of effectiveness. The first is population effectiveness, which looks at the ability of a health care intervention to produce a measurable improvement in the health of the population. Second is the attributable effectiveness defined as the difference in outcome between a group given a treatment and a group with no treatment. Third is population - attributable effectiveness, which looks at the impact of health service in the population. Fourth is relative effectiveness defined as the ratio of the outcome between individuals receiving a health care program and those who are not.

Long and Harrison (1985) define health services effectiveness as a measure of the degree to which the objectives of a policy programme treatment; pattern of care or resource group has been achieved. They argue that this definition explicitly links the objectives of the service or procedure to actual performance, linking objectives to their achievement. However, as stated by Flood et al (1982), health services organizations such as hospitals have multiple objectives and programs, which involve a wide range of interrelated services to a diverse set of patients and often engage in non-patient care activities such as teaching and research. Hence it is difficult to decide which aspect to emphasize, and measures of effectiveness vary according to the aspects selected. Thus, according to Flood et al (1982), assessing effectiveness can be difficult and controversial in professional organizational settings such as hospitals. They suggest focusing on the quality of care aspect of hospital effectiveness. Although this is clearly a limited focus, Long and Harrison (1985) argue that it provides a simplified way of looking at effectiveness with easily available data and no measurement problems. Vouri (1982) comments that whilst quality of care may not ascertain effectiveness in any complete sense, it can nevertheless be used to suggest problems that are worthy of closer inspection.

Having identified quality of care as likely to provide the main measure of effectiveness in studies of this sort, it is necessary to define quality, discuss its importance and identify its different dimensions in the hospital setting.

Quality in the health care context is an old concept. As Reerink (1990) stated in his review of quality of health care "*In ancient times man's notions - like his feelings - were by nature a little crude and primitive, and quality of care was treated in an equally primitive way, consequently focusing on outcome only*". He mentioned the seventeenth century BC Code of Hammurabi about the punishment inflicted upon physicians who delivered care of bad quality resulting in injuries to patients. He further states that the Babylonians recognized that care can do harm and defined goodness as the absence of harm. In his historical review he states that health care literature before 1933 does not provide any study on quality that can help in its definition. He also states that since the beginning of the last century descriptions of quality of health care have begun to take form in long lists of categories that make up the elements of quality.

Quality of medical care has been defined in many ways. However definitions of quality have relied on subjective perceptions that vary depending on the individual making the assessment (Martin 1987). As Donabedian (1980) concluded that " *there are several definitions of quality, or several variants of a single definition; and that each definition or variant is legitimate in its appropriate context*". He suggests, "*A balance of health benefits and harm is the essential core of a definition of quality*". From that sense he defines quality of medical care as "*the management that is expected to achieve the best balance of health benefits and risks*".

Sarma (1991) argues that in a hospital situation quality has an infinite number of elements and it is impossible to assess them all, however improvements in performed elements of care can be demonstrated by putting each of these elements through measurable criteria.

Lee and Jones in their " articles of faith" published in 1933 described Quality of medical care as " *The application of all necessary services of modern scientific medicine to the needs of all people*" (Reerink 1990).

Blue Cross/ Blue Shield defines quality of medical care as " *The degree to which care is available, acceptable, comprehensive, continuous and documented*". However a widely used definition is that given by Donabedian (1966), which defines quality of care as " *the extent to which actual care is in conformity with preset criteria for good care*".

Lohr (1988), Lohr and Brook (1985) and Aday et al (1993) see that quality is the gap between what is achievable (efficacy) and what is achieved (effectiveness). Ginsburg and Hammons (1988) explain quality as " *Care is of good quality insofar as it contributes to the patient's health and well being*". The Institute of Medicine defines quality of care as " *the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge*" (Longo and Daugrid 1994).

The Quality Management Working Group of the White House Task Force on Health care Reform used this definition of quality of care (Lavizzo-Mourey 1994). Similarly The Office of Technology Assessment (OTA) defined quality of health care as "*The degree to which the process of care increases the probability of outcomes desired by patients, and reduces the probability of undesired outcomes, given the current state of technology*" (DesHarnais et al 1990).

There are two major forms of quality identified in the literature: **technical**

quality and **inter personal quality**. These two dimensions reflect the diversity of acceptable outcomes for patients and the complexity of the medical care process (Sisk et al 1990). The first is also called "quality in fact". It refers to the application of medical science and technology to a problem, in terms of the conformance to professional specifications (standards); it includes knowledge, skills and judgment, and referred to the " science" of health care (Donabedian 1980; Bopp 1990; Lohr 1988; Omachonu 1991). Donabedian (1988) argues that technical quality of care is proportional to its effectiveness. He explains this relationship by saying:

"The technical performance depends on the knowledge and judgment used in arriving at the appropriate strategies of care and on skills in implementing those strategies. The goodness of technical performance is judged in comparison to the best practice. The best practice, in its turn, has earned that distinction because, on the average, it is known or believed to produce the greatest improvement in health. This means that the goodness of technical care is proportional to its expected ability to achieve those improvements in health status that the current science and technology of health care have made possible. If the realized fraction of what is achievable is called effectiveness, the quality of technical care becomes proportionate to its effectiveness."

The second form of quality, also termed "perceptual quality" or "functional quality", refers to the personal (social and psychological) interaction between patient and provider, and the humanistic aspects of their relationships. It reflects the consumer's judgment about a product's overall excellence and superiority, and is referred to as the " art " of health care (Donabedian 1980; Sisk et al 1990; Lohr 1988; Zeithaml 1988; Anderson and Zwelling 1996; Omachonu 1991). Health care in this sense (interpersonal) must meet socially defined values and norms. Privacy, confidentiality, empathy, honesty, and sensitivity are virtues that the interpersonal relationship is expected to have (Donabedian 1988). For (Long and Harrison 1985) it is the notion of acceptability. Another aspect of quality of care referred to by Donabedian (1980) is the amenities of care, which concerns the elements of comfort, convenience and attractiveness of facilities. However this aspect has not been widely used in the literature as an approach for the assessment of quality of care.

Technical quality allows for the use of quantitative data as contrasted with perceptual quality, which uses qualitative data obtained through questionnaires and interviews. However, there may be some exceptions to this rule. Waiting time is a quantitative measure, but it is commonly used as an indicator of functional quality (Anderson and Zwelling 1996). Perceptual quality is subjective. It is based on the personal values and preferences of individual (Cameron and Whetten 1983).

Technical quality of care can be measured in a number of ways. Various approaches for measuring quality of care involve utilizing the constructs of structure, process and outcome presented by Donabedian (1966). He categorized medical care in terms of structure, process and outcome for the purpose of determining various aspects of quality. The implied linkage among these components under this categorization assumes that structural elements of medical care influence the medical care process, and that process in turn influences the outcome. Since that time this quality of care paradigm has become the framework for assessing quality (Aday et al 1993; Longo and Daugrid 1994).

The **structure** aspect of quality relates to the manner in which personnel and facilities are organized to provide services. The concept includes the human, physical and financial resources that are needed to provide medical care. As Donabedian (1980) stated, " *the term embraces the number, distribution, and qualifications of* *professional personnel*", and hence he believes the structure aspect of quality has a great importance in planning, designing and implementing health services systems.

Process includes the activities of physicians and other health professionals engaged in providing medical care (Donabedian 1980); in other words what is done to or for a patient with respect to his or her medical complaint. It is based on evidence relating to the performer's activities in carrying on work (Scott and Shortell 1983). Donabedian (1980) argues that elements of the process of care do not signify quality until their relationship to desirable changes in health status has been established. However there is a very wide range of processes undertaken by the physicians and health professionals to deliver care for the patient, and the link between the process of care and patient outcomes has been established for relatively few procedures. Therefore, process measures should be limited to those known to improve or harm patients' health and satisfaction (Sisk et al 1990). Surgical wound infections, C-section rate and use of ICU are examples of process measures of quality.

Outcome is the end result of medical care, namely changes in a patient's health status and satisfaction. It refers to whether or not the process has produced its intended effect (Donabedian 1980; JCAHO 1994). Important characteristics of outcome, as pointed out by Lohr (1988), include dimension of health (e.g. physiological, physical, or emotional); definiteness (e.g. an objective or observable event such as death, versus a subjective or not directly observable phenomenon such as alleviation of pain.) The range of outcome measures as pointed out by Russel and Cole (1987) and Lohr (1988) comprises " the five D's": death, disease, disability, discomfort and dissatisfaction. Deaths, infections, other complications, unplanned surgery, drug reactions and readmissions are objective quality elements that may be used for measuring outcome (Martin 1987).

Death rates, especially case mix or severity of illness adjusted, have been most frequently used as an outcome measure in the hospital studies (Longo and Daugrid 1994; Brownell et al 1999; Thomas et al 1993; Dubois et al 1987a; Blumberg 1986). Maternal, infant and postoperative death rates are counted as important statistics in outcome measurement (Griffith 1978; Siu et al 1992). Klein (1982) argues that death rate is reasonably robust statistical fact; therefore comparisons across time and between countries are in theory feasible.

In contrast (Donabedian 1966; Griffith 1978; McAuliffe 1979; Brook and Lohr 1985) see the problem with outcome methods in general is that attributing changes in outcomes to medical care requires distinguishing the effects of medical care from the effects of the many other factors that influence patient health and satisfaction.

Historically most quality assessment work has stressed care process evaluations and levels of the technical quality of care. However health accounting concepts, which started in the late 1970's because of concern about the effects of expenditure containment on patient well being, swung the emphasis to patient outcomes (Lohr 1988; Doessel and Marshal 1985).

Griffith (1978) suggests that the best system of quality assessment would include structure, process and outcome approaches. He argues that structural measures encourage high quality but do not guarantee it, procedural measures are highly technical but identify specific events, which can be corrected, and outcome measures focus on the end point. Sisk et al (1990) also regard them as complements rather than alternatives for assessing quality. However Donabedian (1966) concludes, "*outcomes, by and large, remain the ultimate validators of the effectiveness and quality of medical care*".

Following the suggestions of Griffith (1978) and Sisk et al (1990), this thesis utilizes the available data on structure, process and outcome indicators of quality. The sort of data suggested by Donabedian (1966) is not available for this study, as has been the case for many other studies.

2.4 Efficiency

Efficiency is another dimension of performance that has received much attention in the health services sector. Developed countries such USA, Canada and the UK have enacted policies to contain costs, control health care spending and improve efficiency in their hospitals. These policies have led to changes in the patient care services delivered by hospitals, such as: reductions in the average length of stay; changes in the number and type of inpatient admissions; and shifting services to non-inpatient settings (Sochaliski et al 1997).

There are several reasons for studying hospital efficiency in particular. Firstly hospitals represent a significant proportion of health expenditure. According to Health Care Financing Administration (HCFA)[7], hospitals spent 35.65% of the national health care expenditures in the USA. In Saudi Arabia hospitals utilize over 70% of the health care manpower provided by MOH. Second are opportunity cost considerations.

Improvement in a hospital's efficiency may result in savings in the expenditures that might in turn be devoted to improving equity or other important health activities, such as prevention, health education and research. Thirdly policy makers can use efficiency measures for planning and better decision-making

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7 HCFA is Health Care Financing Administration; a USA agency managing Medicare and Medicaid programs.

processes. Finally hospital managers can use efficiency measures to monitor their hospitals' activities and compare their performance with other hospitals.

In general terms efficiency, also referred to as operational efficiency, means the ability to produce the desired effect with a minimum of effort, expense or waste (Koss and Lewis 1993). According to Aday et al (1993), efficiency is the ability to produce the combination of goods and services with the highest attainable total value, given limited resources and technology.

Bauld III (1987) defines efficiency as "the ratio of output per unit of input or the ratio of production to the capital and resources invested". However, because there are many categories of inputs (e.g. capital, labor and equipment), inputs are often measured in monetary value; and efficiency is generally defined as the cost per unit of output (Scott and Shortell 1983).

A term interchangeably used for efficiency is productivity, which eliminates the need to determine costs, and refers to a subclass of efficiency that emphasizes outputs as related to inputs e.g. Labor (Scott and Shortell 1983). In this case efficiency is measured in terms of maximizing the quantity of a commodity that can be produced for each set of inputs (output oriented), or alternatively, the minimum amount of inputs required to produce different levels of outputs (input oriented) (Browning and Browning 1989).

Production theory identifies several types of efficiencies. Of these economists typically focus on allocative, technical and scale efficiency (Golany et al 1990). Allocative efficiency concerns the allocation of resources within the overall system, and implies using the best mix of inputs at prevailing prices. According to Aday et al (1993), allocative inefficiency occurs in health services when substantial resources are allocated to treatments of questionable effectiveness while proven screening and prenatal preventive services are neglected. Allocative efficiency is derived from the notion of Pareto optimality, which implies that no possible reorganization of production can make anyone better off without making another worse off (Samuelson and Nordhaus 1992; Long and Harrison 1985).

In contrast to allocative efficiency, which focuses on the intraorganization behavior, technical efficiency, also referred to as x-efficiency, measures the extent to which a given combination of inputs produces as much output as is possible. Inputs under technical efficiency may be expressed in physical terms, or in terms of money, (Long and Harrison1985; Rosko 1990; Grover and Flagle 1990; Golany et al 1990).

For a hospital to be technically efficient, an increase in an output requires a decrease in at least one other output or an increase in at least one input, alternatively, a reduction in any input requires an increase in at least one other input or decrease in at least one output (Magnussen 1996).

Scale efficiency refers to producing at the optimal scale. Scale inefficiency exists when increasing or decreasing the output level can lower the average cost of production. (Gardner and Grace 1993)

Studies of cost inefficiency mostly calculate only the technical efficiency and scale efficiency components, because calculation of the allocative component requires information on the relative prices of inputs, which may not be available (Lovell 1993; Byrnes and Valdmanis 1994).

Ferrier (1994) agrees with this, although he argues that in studying relative efficiency, regardless of organization form and objectives, the concern should be with technical efficiency. However the focus of this thesis is on technical and scale dimensions of efficiency.

2.5 Organizational Structure

In organization theory, organization is defined as " relatively permanent social entities characterized by goal- oriented behavior, specialization, and structure" (Brown and Moberg 1980). An organization as defined by systems theorists is " a system, and a system is a set of elements with relationships among them" (Ashby 1960; Hall and Fagen 1956; Miller 1965; Von Bertalanffy 1969). As Georgopoulos (1972) points out, in the case of large-scale human organizations such as hospitals, the basic elements of the system are behaviours, social activities, and work roles defined in terms of human activities or, more precisely, patterned and regulated human activities. He further points out that organization involves connected elements (structure and form), patterned activities, interdependence among elements, wholeness, constancy and continuity. According to Levey and Loomba (1984), organization is a key managerial function, which implies coordination of resources toward the end of more efficient and effective attainment of goals. Becker and Neuhauser (1975) assert, " Organizations arise when someone expends resources and establishes some procedures for their use in order to achieve a goal".

Shortell (1976) points out that " *Major organizational theory issues concern the ability to build more comprehensive theories of organizational behavior; to develop a fuller understanding of the consequences of technological change; and to examine in greater detail the management and implementation of change in organizations, particularly in regard to the coordination and integration of new work activities with old ones and the rearrangements of power and role relationships among those affected*".

Organizational effectiveness is a major variable in any organizational research. As Cameron and Whetten (1983) stated " *Empirically, the construct of organizational* *effectiveness is not likely to go away because it is the ultimate dependent variable in any organizational research. Evidence for effectiveness is required in most investigations of organizational phenomena. The need to demonstrate that one structure, reward system, leadership style, information system, or whatever, is better in some way than another makes the notion of effectiveness a central empirical issue".*

Throughout the 1960s the interest of organizational researchers was mainly concerned with identifying the determinants of organizational structure. However the relation of organizational structure to performance of organizations became a major interest in the 1970s with attention given to discovering the consequences of varying structural arrangements, looking at what characteristics of functioning or performance differentiate one structure from another (Flood et al 1982; Rhee 1983). Several studies have focused on the organizational aspects of institutional settings, with emphasis on hospital settings. Among these were several studies that examined the relation of hospital structure to hospital performance (Heybrand 1973; Pugh et al 1968; Child 1974; Goodman et al 1977; Price 1972; Steers 1977; Georgopoulos 1962). Shortell (1976) after reviewing 19 comparative empirical studies of hospitals, identified 7 sets of organizational variables relevant to developing a more comprehensive approach to organizational analysis:

1. Environment,
2. Goals,
3. Technology,
4. Decision-making structure,
5. Reward system,
6. Modes of coordination,

7. Work specification activities.

Starfield (1973) hypothesized that five variables facilitate the health outcomes of patient care in the hospitals:

1. Personnel,
2. Facilities and equipment,
3. Organization (leadership, politics, planning and goals, organizational control and consumer involvement),
4. Information flow,
5. Finance.

Shortell et al (1976) hypothesized that hospital efficiency and quality of care (they are major dimensions of hospital performance) can be each viewed as a function of the hospital's external and internal environment, technology, and certain internal organization design variables. They identified a number of organizational design variables; among them are " work procedures, and types and methods of coordinating hospital's work". Levey and Loomba (1984) argue that an organization may be viewed as both process and entity. Process includes assembling human and other resources, structuring work and authority relationships, and establishing communication channels. Similarly Schulz and Johnson (1990) argue that the objectives of organizational arrangements are to facilitate coordination of efforts, communication among responsible parties and accountability of results.

Organizational structure is one aspect of an organization's performance assessment. Organizational structure is defined as the relatively enduring allocation of work roles and administrative mechanisms that create a pattern of interrelated work activities and allow the organization to conduct, coordinate, and control its work activities (Jackson and Morgan 1978). According to Levey and Loomba (1984), organization structure refers to the authority – accountability relationships among various hierarchical levels and persons who perform different organizational tasks; it formalizes work assignment and relationships among organizational parts. Moseley and Grimes (1976), in studying hospital organization and effectiveness, argue that two important impacts on organizational effectiveness are: organizational structure variables and coordinative and integrative mechanisms employed within the organization. They identified the primary variables of structure as:

1. Specialization,
2. Standardization,
3. Formalization,
4. Centralization,
5. Traditionalism,
6. Configuration.

Gibson et al (1979) point out that organizational effectiveness is an all-encompassing concept, which includes a number of component concepts. The managerial task is to maintain the optimal balance among these components. Scott and Flood (1987) identified 4 major dimensions of hospital structure in accounting for differences in hospital performance:

1. Differentiation,
2. Coordination,
3. Power,
4. Staff qualifications.

In the context of this research, it was important to limit the amount of information of this sort to be gathered and analyzed. Given the aim of this study, organizational elements investigated were limited to those that were expected to be associated with the differences in the type of management (contract versus traditional). When entering in hospital management contracts, the MOH has given certain organizational elements specific attention in the contract specifications. Such elements are:

- Organizational chart including (lines of authority and responsibility, departmentalization, job description);
- Work specification activities including (policies and procedures, quality improvement function, utilization review);
- Communication;
- Hospital information system;
- Administrative staff qualifications.

2.6 Performance Indicators

Recognizing that there is no single dimension of performance implies that there is no single measure of performance, but rather a series of measures, often called performance indicators. Hospital performance indicators are detailed statistics on the services provided by the hospital. They largely measure quantity of services.

Performance Indicators (PIs) can be classified as indicators of input, activity or process, or outcome (Geddis 1988). The first refers to the availability of resources in terms of staff, finance, equipment or buildings; the second refers to patient treatment or care, and the third refers to assessing the health improvements of patients and the result of medical interventions.

Some indicators are not designed to be direct measures, especially for quality of care. However they can raise questions about quality of care and can be used to alert users to possible opportunities for improvement in processes and outcomes.

From the Joint Commission on Accreditation of Health Care Organizations (JCAHO) perspective, PIs are flags to alert users to possible opportunities for improvement in processes and outcomes (Turpin et al 1996).

Performance indicators can be used to see where a hospital stands in relation to other hospitals. As John Yates (1983) has set out, the advantages of Performance Indicators are:

1. Highlight variations in resource use amongst hospitals.
2. Highlight areas of atypical performance for management investigation and action.
3. Provide objective support for discussion between management and financing authorities.

Jenkins et al (1988), in a survey of the use of Performance Indicators in the National Health Service, found that managerial uses of performance indicators fall into two broad categories: identifying problems and providing supporting evidence for policy decisions.

Although PIs are very useful tools especially for management they have important limitations

1. They are not standards of performance nor do they measure the actual performance, they are merely comparative measures.
2. They should be used only in the context of the objectives defined for obtaining them; they are not independent of the purpose for which they were devised.

However the greatest problems in producing performance indicators are the availability, adequacy and reliability of timely information, which requires a sufficiently developed information systems to produce them (Yates and Davidge

1984; Arnold 1990). The accuracy of the PIs depends on the information provided, how accurately and completely they are recorded and at what level of detail. Yates and Davidge (1984) identified three areas of reservations about using routinely collected data: "technical", "conceptual" and "emotional". The technical reservations were concerns about the accuracy, completeness, relevance and timeliness. The conceptual reservations were concerned with the examination of performance in terms of inputs, process, outcome, need, demand and environmental influences. The emotional reservations concern non-quantitative measures of quality, e.g. tender loving care and bedside manner.

PIs provide a wide range of measures of the structure and process aspects of health services, but provide little on the side of outcome. This may be due to the limitations of outcome measurement has as an assessment tool. Using these measures to examine the performance of health services depends on understanding the relationships between these dimensions (Yates and Davidge 1984)

Ideally it would also be desirable to use PIs which reflect external factors (e.g. demand on the service) and internal factors (e.g. case mix and complexity of illness). However in this study, as in other studies, data availability limits the choice of performance indicators. This limitation is countered as far as possible, in this research by careful selection of PIs, appropriate multivariate analyses, and informed interpretation of results.

The performance indicators used in this research are divided in three groups, to reflect the three dimensions of hospital performance identified earlier, as shown in figure 2.1. The choice of particular indicators is described in chapter 4.

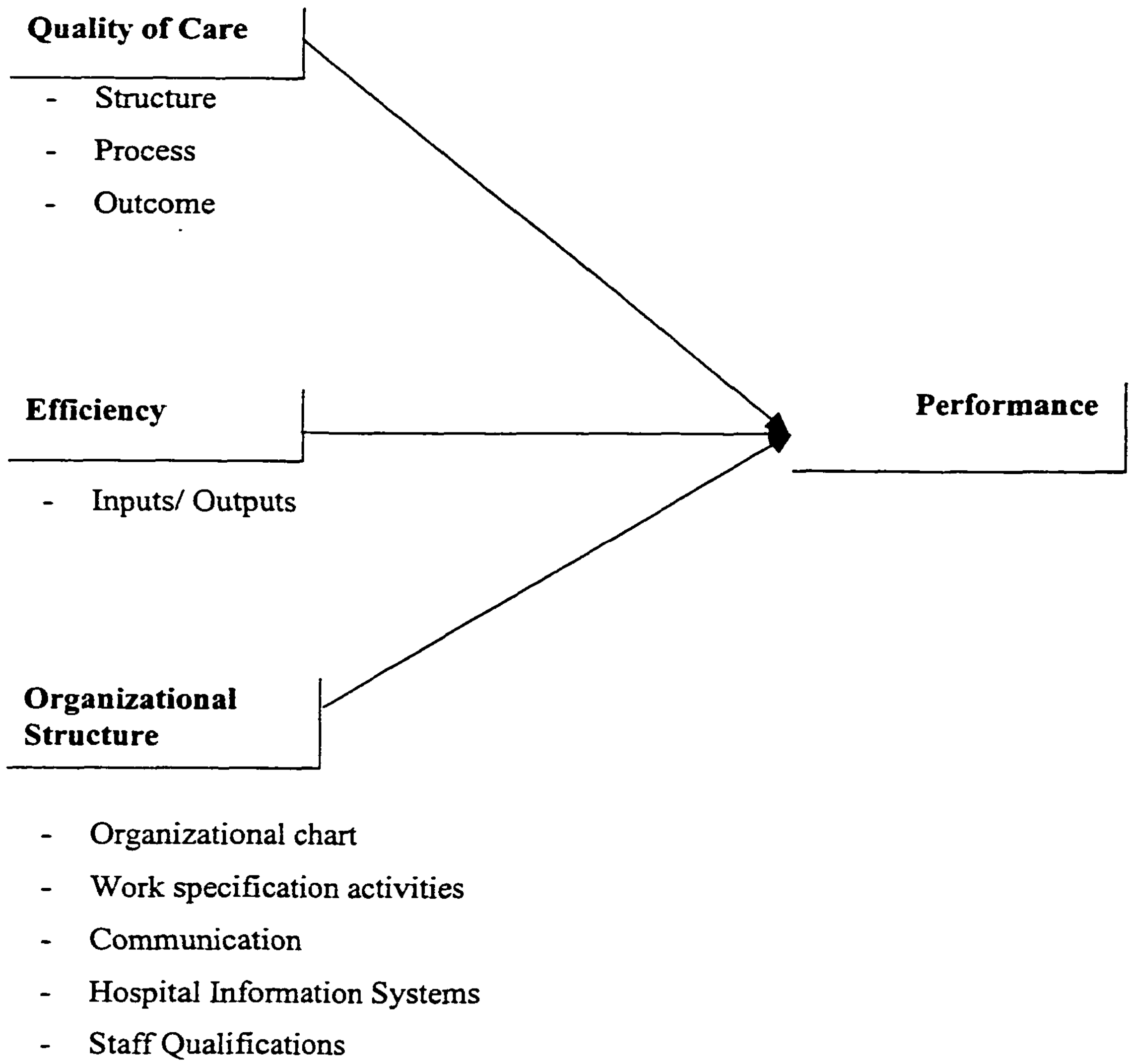

Figure 2.1: Performance model summary

Chapter Three: Contract Management Research

The main purpose of this thesis is to assess the impact of contract management on the performance of the MOH hospitals in Saudi Arabia. Thus hospital contract management is an important concept to be identified and discussed. However, whilst the main concern of this research is contract management (CM) in Saudi Arabian hospitals, most research into CM has been undertaken elsewhere. This literature is used in this chapter for three purposes. First to provide an overview of hospital contract management perspectives in two different health care industries, in the USA and in the UK. Second, hospital CM motives, policies, structures and processes are discussed. Third, implications relavant to the MOH in Saudi Arabia are analyzed in terms of possible research questions, methods and findings.

3.1 Perspectives of Contract Management

Restructuring public services to be more efficient, effective and responsive is a central goal of governments throughout the world (Smith 1996). During the 1980's both UK and USA governments experienced changes stemming from the monetarist economic policies (Gutch 1992; Jost et al 1995). In both cases the aim was to open up public services to market competition, with the hope that contracting, as a market mechanism through which purchasers influence providers of health care, will reduce costs and improve service quality (Smith 1996; Mechanic 1995; Flynn et al 1995).

In the UK the Thatcher government emphasis on the "free market" was a major factor behind the development of contracting in the public sector. The White Paper " Working for Patients", solicited by the Conservative government in 1989 and adopted by the Parliament in 1990, set a number of proposals for change in the NHS. These were mainly the separation of the responsibilities of planning and managing the provision of services, and the introduction of competition through an internal market for health care provision, which was created by splitting the providers and the purchasers of health care services (HFM 1990; Maniadakis et al 1999). The 1990 NHS and community care act established contracting for healthcare between purchasers and providers within the NHS internal market on the basis of the following principals, which according to Dredge (1995), underlie the operation of the internal market:

- *Prices should be based on cost.*
- *Costs should be arrived at on a full cost basis.*
- *There should be no planned cross subsidization between contracts.*

In this new context, directly managed hospitals or NHS trusts were providers and were supposed to compete for the business of General Practitioners and Health Authorities. They, in turn, were responsible for purchasing health care services for the population they covered by spending budgets allocated to them by the government. For hospitals to be competitive and attract contracts, they had to minimize the cost at which they provided their services and/ or to provide services of high quality relative to their competitors, and thus take benefit of the differentiation (Maniadakis et al 1999).

The claimed advantages of this contracting process as summarized by Dutfield (1993) were:

- *Securing better value for money;*
- *Clarity of responsibility, thus easier to hold those responsible to account for their performance;*

* *Promoting quality public provision of service;*
* *Guaranteeing service – user involvement;*
* *Improved management and better utilization of resources;*
* *Develops an effective partnership between purchaser and provider.*

Although the UK health care system has taken steps toward a free-market, it is still characterized as a quasi-market for many reasons. As argued by Flynn et al (1995) the actions of purchasers and providers and the process of contracting are highly constrained:

* *The trade is non-profit and ownership of assets remains ultimately with the state;*
* *The consumers do not pay for services at the point of consumption and their 'preferences' are mediated through a variety of professionals and managers;*
* *Financial control remains ultimately in the hands of government (who sets the budgets and borrowing limits for trusts and health authorities);*
* *The entire system is subject to extensive centralized regulation by the state.*

In contrast to the level of highly structured organization that traditionally existed in the NHS and continues to persist even after the reforms, the US health care system historically is largely unstructured, with providers being independent and free-standing institutions (Jost et al 1995; DeVries 1978). The provider side includes independent, free-standing hospitals and other health care institutions, and individual health care professionals. The purchaser side includes individual patients, Blue Cross/ Blue Shield plans; commercial insurers; government programs; managed care plans and self-insured employers. The US has a lower level of government health care financing than any other industrialized nation, and relies on the private provision of medical care (Schieber et al 1992). However the US health care system has been moving toward greater integration with increasingly formalized purchaser and provider relationships. This movement has been driven by market forces rather than government decree (Jost et al 1995; Smith 1996). As stated by Mckinney et al (1991) "*financial and competitive pressures have transformed a loosely structured hospital industry into a crazy-quilt of systems, alliances and networks*" Nevertheless, the ultimate goal of integration in the US hospital industry is superficially similar to that being pursued by the UK health reforms, which is creating functioning markets for health care (Jost 1995).

Integration among hospitals in the US, in the form of multi-institutional arrangements, has moved the hospitals from a less formal to a more highly structured system (DeVaries 1978). According to the classification schemes developed by DeVaries, the multi-hospital arrangements have taken a number of forms:

- *Formal affiliation*
- *Shared or cooperative services*
- *Consortia for planning or education*
- *Contract management*
- *Lease*
- *Corporate ownership but separate management*
- *Complete ownership*

Several reasons have been cited for this growth in multi-institutional arrangements, among them are: advantages of economy, quality, accessibility and power, increased state and federal regulations over health costs, the need for developing various administrative and clinical capacities, and increased assurance of hospital survival (Lowe 1981). He described Contract Management as being the intermediate form between the less committed, less formal and the more formal and committed forms of hospitals multi-institutional arrangements.

Hospitals under the US health care system can be categorized into 3 types as follows (Rundall and Lumbert 1984):

- Private hospitals, also referred to in the literature as " investor- owned", which are hospitals owned and operated for the purpose of making profit for their owners.
- Public hospitals are government owned and are of two types, federal hospitals such as those within the Veterans Administration and the Public Health Service, and public-general hospitals owned by state, city, and county governments. This category includes publicly owned university hospitals.
- Voluntary hospitals, which are private not-for profit hospitals, partially supported by voluntary contributions.

Since the beginning of the seventies, hospitals of all three types using contract management increased markedly in the United States. It was seen as the most rapidly developing form of multi-institutional arrangement in the USA hospital industry (Zuckerman and Wheeler 1982). At the same time, however, contract management was the most ambiguous of hospital multi-institutional arrangements in that policy control and ownership of assets were retained by the managed hospital but management control resided with an outside organization (Alexander & Morrisey 1989). Some CM services are provided by private and not-for-profit autonomous hospitals, multi-hospital systems, hospital associations and firms specialized in CM. (Brown and Money 1976; Rundall and Lambert1984). However contract management is mostly provided by multi-hospital for-profit corporations (Biggs et al 1980).

In the American Hospitals Association (AHA) Annual Survey of Hospitals in 1987, contract managed hospitals represented 12.4% of the total number of hospitals compared to 10.4 % in 1982 (Lutz 1994). A survey of 1100 hospital Chief Executive Officers (CEOs) conducted by Hospitals Journal in 1990 revealed that more than 43% of the respondents used contract management services and most of them were satisfied with the results. When the survey was again conducted in 1993, the results showed that of the 1185 respondent CEOs more than 55% reported using contract management. The Modern Health Care's 1991 survey of contract management firms showed that more hospitals were welcoming contract management into their facilities. The 75 companies responded to the survey reported a 13.7% increase in contracts with hospitals from 1989 to 1990 (Lutz 1991).

Contract Management is defined as a formal arrangement whereby a hospital hires an outside organization to provide comprehensive management of the hospital's operations (Brown and Money 1976; Rundall and Lambert 1984). The services provided within the management differ according to the details of the agreement, ranging from appointing an administrator to taking full responsibility of management and operation. As Brown and Money (1976) described, management contract usually contains the following elements:

1. The board of directors of the managed hospital controls policy and retains legal responsibility for and ownership of the facility;
2. The managing organization appoints an administrator subject to board approval;
3. The administrator manages the operation of the hospital under a budget approved by the board and obtains approval of key decisions from the board;
4. The managing corporation provides specialized services and personnel to the managed hospital; the administrator may implement new management

systems, perform feasibility studies, suggest changes in services and take daily management responsibility for the hospital. All major changes in operations or activities are typically performed with the approval of the board of directors.

Developments in the UK and US health care systems have both led to the emergence of contract management. Furthermore despite the differences between the two health care systems, both countries emphasized the role of market forces and competition in seeking new arrangements better suited to address the growing population demands and needs, and the capacity of public budgets to meet them (Mechanic 1995). However the two countries used CM in opposite perspectives. The US perspective looks at CM as a multi-institutional arrangement, where for-profit organizations are hired to provide management of the hospital operation, so moving the hospitals into a more competitive environment. Whereas in the UK, CM is used as a tool to introduce market forces into the publicly owned health care service, where the purchasers and the providers are within the system, and competition is hosted within the system.

The Saudi Arabian health care system is heavily dependent on the public health services provided by the MOH. As a result it has a great similarity in terms of structure to the UK National Health Service, both being characterized by a top-down administrative model. However the motives of the Saudi MOH to use contract management has much in common in general terms with motives mentioned in several US-based studies, i.e. to overcome the professional manpower recruitment, financial and administrative problems.

The nature of the CM process is, not surprisingly, similar in the US and in Saudi Arabia. The first hospital management contracts in Saudi Arabia were launched by US based companies such as Hospital Corporation of America (HCA) and American Medical International (AMI). Other American based companies were also among the first to enter into hospital contract management in Saudi Arabia, e.g. Charte Medical Corporation (CMC) and Whittaker Corporation. As Berliner and Regan (1987) stated " *With the rapid growth of the oil economics of the Middle East in the early 1970s, some of the 'petro-dollars' were invested in building up the infrastructure of the oil-producing countries in an effort to improve the standards of living for the population. Since these countries had little experience with modern hospitals and medical care, they awarded construction contracts to get the institutions built and management contracts to operate the facilities once they were erected. Many of these contracts were given to American proprietary hospital companies*".

Khan (1986) in describing the hospital contract management process in Saudi Arabia stated " *In many ways, contract management of hospitals in Saudi Arabia follows the same definitional patterns as contract managed hospitals in the USA. Thus, in Saudi Arabia, some unit of the government owns, controls, and monitors the hospitals and sets up the goals and service policy while the contractor provides the staff and services and manages day-to-day operations*"

However, differences in the healthcare system structures between Saudi Arabia and the USA mean that problems encountered and potential benefits will have important differences. Differences may also come from contractual agreements, with the Saudi Arabian MOH contracts based much more on input and method, rather than on performance specifications. For example MOH contract specifications provide detailed guidance to the contractor and detailed requirements of the contractor in managing and operating the hospital, e.g. lists of required staff in all categories (medical, nursing, technical and administrative).

3.2 Effects of Contract Management

The motives for hospital entry into contract management vary greatly in the literature. Derzon et al (1981) surveyed trustees at 78 hospitals. They cited the reasons to use contract management as: the need to improve cash flow (most often), cost reduction, and replacing a retiring or unsatisfactory administration. A Kimberly and Rosezweig (1988) study agreed with these findings and added physician recruitment and retention as a further reason.

Brown and Money (1975) claim that a management contract provides the hospital with the flexibility to acquire the expertise to address specific operational problems without sacrificing policy control or assets ownership. Alexander & Morrisey (1989) argue that a hospital's choice of contract management stems from the benefits of resource exchange with the contract management organization. These benefits may include highly trained management, improved financial accounting, purchasing and personnel procedures. They expect that hospitals without the ability or internal expertise to operate both autonomously and efficiently are most likely to enter into contract management. An Alexander & Rundall (1985) study added another two reasons: easier access to capital markets and economics of scale from joint purchasing with other hospitals that share the same managing organization.

From a different perspective Rundall & Lambert (1984) stated that companies selling contract management services promote themselves by asserting that they can:

1. Provide modern management and administrative expertise unavailable or inaccessible in the public sector, by being able to bypass the unattractive pay scales and incentive systems of the civil service and to draw on the skills of a team;
2. Buy or contract for equipment, supplies, personnel and services through

bulk purchasing and sharing of expenses with other hospitals.

According to the Modern Health Care Journal 17th annual Contract Management Survey conducted in 1994, Contract Management has offered a number of advantages, they are:

- Difference in the quality of services rendered-e.g. offering a full continuum of care: inpatient, partial hospitalization, psychiatric home care and outpatient services.
- Unique capabilities, such as sophisticated outcomes measurement systems.
- Ability to increase a hospital's profitability through a rise in revenues, a decrease in costs, or a combination of the two.
- Speed of action, the ability to make it happen, doing it right as fast as possible.

The literature implies that contract management has a positive impact on hospitals' operational efficiencies. Various studies have revealed improvements in profitability and more efficient use of fixed assets following the adoption of contract management. Most studies were cross-sectional, looking for relationships between hospitals' operational characteristics and type of management (contract and traditional), allowing for other characteristics: e.g. ownership, size and location. A few descriptive longitudinal studies looked at the impact of contract management on hospital efficiency.

Wheeler and Zuckerman's (1984) findings also indicated that a managing organization concentrates initially on improving the economic and financial performance of the hospital, then on recruitment and retention to secure necessary personnel, and lastly on strategic planning and marketing.

Morrisey and Alexander (1987) report that management companies, in the first two years, concentrate on improving the financial position of the hospital through improved accounts receivables and pricing decisions, as well as making changes in accounting and management information systems. In the second and third years attention is focused on staff recruitment and retention. Subsequent years focused on strategic planning and marketing of hospitals' services. Kahn and Harju (1984) believe that a good management company should be able to save a hospital from three to seven times the contract fee. However, a poll of 250 Hospital CEOs conducted for Hospitals Journal by Professional Research Consultants, revealed that only 26% atributed savings in efficiency to contract management; 54 % did not, and 20% were uncertain (Souhrada 1991)

The impact of contract management on hospitals has also been investigated by Wheeler and Zuckerman (1984), where they see strong evidence to indicate that contract management improves the ability of hospitals to meet their objectives. The management contract provides a hospital with an infusion of managerial resources, which can increase operating efficiency. Better operating efficiency in turn should facilitate achievement of hospital objectives and improved hospital operation will usually generate benefits for the community. They argued that the infusion of managerial resources can improve the production efficiency and the allocation efficiency. Consistently, Biggs et al (1980) found that administrators in contract managed hospitals had significantly higher levels of education compared to those in traditionally managed hospitals.

In assessing the effect of contract management on hospital performance Biggs, Kralewski and Brown (1980) found few major differences between hospitals under contract management and hospitals under traditional management. Contract managed hospitals tend to offer a broader range of services, especially in the outpatient area, and show lower cost per patient stay due to lower employee-to-bed ratios, lower payroll to total expenses ratios, and shorter lengths of stay.

Alexander and Rundall (1985) agree with some of these findings. In examining the effect of contract management on operating efficiency and services structure they found payroll and operating expenses to indicate more efficient operation by CM. However expenses per patient day was found to be higher in CM hospitals, indicating less efficient operation by CM in the area of cost and expense control. They attributed higher expenses in the CM group of hospitals to several causes, i.e. the cost of contract itself; increase in activity designed to improve revenues such as marketing; expanded services and facilities or initial capital expenditures to renovate and upgrade existing facilities.

Kralewski, Dowd, Pitt, and Biggs (1984) compared the performance of hospitals under contract management with hospitals under self-management by ıssessing the changes in 12 performance indicators in the hospital before and after the contract management. Their findings show an increase in average mark-up, set profit ratios, return on assets and the ratio of employees to inpatients after becoming contract managed. However CM hospitals had no significant improvements in productive efficiency as measured by ratios of employees to beds, by employees to patients, and by occupancy rate.

Alexander and Lewis (1984) in a study assessing the financial characteristics of contract managed hospitals compared to traditionally managed hospitals, found few differences in profitability ratio. They found that operating margins and liquidity improved in contract managed hospitals. However these hospitals had more debt. On the other hand the study did not find differences between the two groups on financial activity ratios.

Rundall & Lambert (1984) indicated in their study that there was a paucity of information on the impact that contract management has on the operation of public hospitals. This was attributed to competitiveness between contracting companies and to the reluctance of government officials to evaluate publicly their decisions to select a given contractor. They hypothesize that contract managed public hospitals operative goals will, over time, become more like those in private hospitals. The study focus was primarily on scope of services and only secondarily on operating performance. Their results indicate the contract managed hospitals tended to add high technology equipment and inpatient services while dropping outpatient services, which implies that hospitals under CM are moving away from non-profitable activities.

More recently, Nutt and Miller (1992) in comparing hospital performance before and after contract management, found significant differences in service scope, efficiency and resource prices. They believe that their results support the use of contract management as a vehicle to promote cost control.

Mills et al (1997) compared the performance of three contract managed hospitals with three traditionally managed hospitals in South Africa. They did not find any significant differences in quality between the two sets of hospitals, but they found that contract managed hospitals provided care at significantly lower unit cost. However they concluded that the cost to the government of contracting was close to that of direct provision, indicating that the contractor captured the efficiency gains.

A US Agency of Health Care Policy and Research study (1994) found that contract managed hospitals are quite different from traditionally managed hospitals in financial performance especially more when contract duration is taken into consideration. Performance of hospitals with two or more consecutive years of contract management is far higher than non-contract managed hospitals. It also found that contract administrators have been shown to be able to reduce costs to below the level of non-contract managed hospitals and to substantially improve the capital structure. However the CM hospitals in the study tend to be small, with low technology, few intensive services and usually located in rural areas.

A small number of studies have looked at the quality of care differences between contract managed and traditionally managed hospitals. Biggs et al (1980) differentiated between quality of service and quality of medical staff. The study used a number of structural and process indicators as surrogates of quality rather than using outcome-related measures of quality. Indicators used were consultation rate among physicians on the hospital's medical staff, hospital accreditation status, the extent of provision of full-time physician coverage in the emergency room and hospital participation in a quality assurance program. Medical staff quality was measured by the number of board certified physicians on the medical staff. Results found no significant difference in the quality of care between contract managed and traditionally managed hospitals. In an other study, Wheeler and Zuckerman (1984) found that management contracts can raise a hospital's level of quality, when quality was measured by ratio of board certified physicians to total physicians.

3.3 Implications for CM Research in Saudi Arabia

The research literature sheds some light on the impact and effect of CM on the hospitals in the USA. It implies that CM has a positive impact on hospitals` operational efficiency. Various studies have revealed improvements in profitability and increases in efficient use of fixed assets following the adoption of contract management. However, very few studies looked at the impact of CM on quality of care and organization.

Much of the CM literature can also be criticized as using small sample sizes, a problem caused by matched pairs sampling methods adopted in the research. Furthermore, hospitals in the samples tend to be small in size, raising concerns about the generalizibility of the results.

Much of the literature is only concerned with the financial performance of the hospitals, reflecting only one dimension of hospital performance. Hence there is a need to expand the performance measures studied to reflect the multi-dimensionality of the potential impacts and effects of CM. The lack of adjustment for other hospital characteristics (e.g. size and regional location), and for differences in types and terms of management contracts (i.e. full service, departmental) is another shortcoming of much of the literature.

Nevertheless, the literature provides a general conceptual framework that enhances the ability to conduct empirical research, and to contribute to the understanding of the impacts and effects of CM. There are clearly differences in the nature of and context of CM in the USA and Saudi Arabia. However some of the research questions and methodologies used provide valuable examples for this study.

The remainder of this thesis seeks to investigate the impact of CM encompassing several distinct dimensions, and using both quantitative and qualitative measures of performance. Three types of management, including two types of CM, are considered and other hospital characteristics are also accounted for in the analyses.

Chapter Four: Data and Methodology

This chapter provides an overview of the study design and methodology used to perform the empirical investigation of the performance of Saudi Arabian MOH hospitals under different types of management.

The study design was initially conceived as one of testing hypotheses about the effects of contract management on indicators of hospital performance. Whilst this formulation is clearly an over-simplification of the real situation to be investigated, it is nevertheless helpful to see the aims of the research expressed in these simple terms. The next section (4.1) therefore describes the aims of the empirical investigation, and the basic hypotheses the work seeks to test.

The following section (4.2) then describes the data sources available in the Saudi Arabian MOH, and the particular variables that have been selected for analysis.

Although the basic aims of the research can be expressed in terms of simple hypotheses, the existence of confounding variables and multiple (possibly alternative, possibly competing) performance measures means that hypothesis testing is just one of a number of approaches used in this research. The range of analysis methods is therefore described in section 4.3.

Finally, as will be explained in section 4.2.2, one important limitation of many hospital datasets, and those in Saudi Arabia is no exception, is the absence of a measure of case mix. This has led to a number of alternative ideas in the literature for case mix adjustment. These are reviewed briefly in section 4.4, before describing the approach to case mix adjustment that has been adopted in this research.

4.1 Study Aim and Initial Hypotheses

The overall aim of the empirical research is to carry out analyses of hospital performance in Saudi Arabia that will inform the MOH in its deliberation of alternative management options.

The fundamental question that the research seeks to answer is " how does the performance of contract managed and traditionally managed MOH hospitals differ?". However, the study needs to go beyond a comparison of the two groups to examine the underlying differences between hospitals and the extent to which they are associated with, or perhaps attributable to, type of management.

A cross-sectional analysis of hospitals' performance is conducted to examine the impact of type of management on the selected dimensions of hospital performance: efficiency, quality of care and organizational structure. Initial questions concerned whether or not contract management was performing better than traditional management, and led to three provisional null hypotheses to be tested.

The first hypothesis addressed the operating efficiency of hospitals', specifically the activity and productivity ratios:

> Hypothesis 1: Indicators of operating efficiency do not differ significantly by type of management.

The second hypothesis concerned quality of care:

> Hypothesis 2: Quality of Care does not differ significantly by type of management.

The third hypothesis pertained to the specific organizational structure elements related to performance:

> Hypothesis 3: Organizational structure elements that have an impact on hospital performance do not differ significantly by type of

management.

However in a multivariate situation such as this it is rarely possible to test such simple hypotheses. There will always be confounding variables (e.g. hospital size, region). Whilst in theory these can be controlled for, in practice, as was the case here, the amount of available data will often severely limit this approach. Hence, whilst the study maintained its interest in these specific questions, a more realistic objective of the research was to undertake analyses likely to shed light on these issues in a way that is expected to be of value to the MOH in Saudi Arabia.

4.2 Study Scope and Data Sources

4.2.1 Scope

The scope of this empirical research is limited to Ministry of Health hospitals in Saudi Arabia. Selecting a single health care provider is desirable because it ensures homogeneity for many institutionally related factors, for example:

- Similarity of environment among hospitals, in particular patient population, regulations, and financial and administrative structures.
- Compatibility of data, where data structures, collection processes and timing are the same for all hospitals.

75 acute general hospitals were selected as the focus of this study. Specialty hospitals, (such as maternity, pediatric and psychiatric hospitals), and very small hospitals, (i.e. primary health care centers enhanced with beds) were excluded. The study also excluded new hospitals, which were opened or switched to contract management within the time period for which data were analyzed.

4.2.2 Data Sources

The primary data used in this study were drawn from the MOH data set, which reports on hospital patient care activities and manpower. This data set is designed and monitored by the MOH Central Department of Statistics, which requires that the data are aggregated and tabulated at the hospital level. The study is based on cross-sectional data for 3 years (1994-1996). A repeated measures analysis checking for a time component was carried out, and was found to not be significant. Therefore 3 year averages have been used in the analysis.

To obtain data on the organizational structure elements related to hospital performance, two types of data were collected. First qualitative data about the management process were obtained through a questionnaire survey developed for this research. The questionnaire was administered to the 75 hospitals' directors. Questions were designed to detect the extent to which organizational structure elements existed in the hospitals. Two questions were open-ended. The remaining 17 used Likert - type scale scores (ranging from 1 for strongly disagree to 5 for strongly agree). The questionnaire was pilot tested in six hospitals, two from each of the three types of hospital management groups. The responses from the six hospitals to the questions during the pilot test and the actual survey were compared and found to be identical, providing a check on the responder reliability in interpreting and answering the questions. Scale reliability was assessed by calculating Cronbach Alpha, which is one of the most widely used indices of internal consistency (Hatcher and Stepanski 1994). It provides the lowest estimate of reliability that can be expected for an instrument. Coefficient alpha was 0.88. Validity of the questionnaire contents was also assessed using two methods. The first was the "*follow up probes*" technique and the second was "*factorial validity*" method. Both assessments suggested a high validity of the questionnaire contents.

The second type of data on organizational structure was quantitative information about the hospitals' management manpower qualifications obtained from the MOH data set. A full listing of MOH data and the survey questions are presented in appendix A.

4.3 Methodology

The overall research methodology has been to apply a variety of analytic approaches to the data, with the hope that the strengths of one would counteract the weaknesses of another, and vice versa. The research has been in three main phases, and is described in chapters 5, 6 and 7.

4.3.1 Phase 1

In the first phase (chapter 5), a series of univariate and multivariate statistical methods have been used to investigate the extent to which the three dimensions of hospital performance (efficiency, quality of care and organizational structure) can be explained by the type of hospital management and/or other factors.

First of all **Ratio Analyses** have been undertaken for a large number of individual performance indicators derived from the original data set. In particular, analysis of variance (or appropriate non-parametric tests when the data is qualitative) have been used to investigate the extent to which variations in individual performance indicators can be explained by type of management, after allowing for important confounding variables. There were a total of 35 performance ratios derived from the raw data that were selected for this phase, and are described below in terms of 'dependent variables', 'independent variables' and 'confounding variables'.

A. Dependent Variables

The dependent variables used in the analyses are listed below, grouped by the theoretical construct for which each is an operational indicator.

A.1 Operating Efficiency Variables: A goal attainment approach to the study of hospital performance suggests the use of hospital input / output ratios and measures of hospital resource utilization as dependent variables for hospital efficiency assessment. The 21 operating efficiency variables selected from the available data (together with their variable names) were:

- Average length of stay (**ALOS**)
- Occupancy Rate (**OCC_R**)
- Bed Turnover Rate (**BTOR**) (i.e. Discharges per Bed)
- Bed Turnover Interval (**BTOI**)
- Outpatient visits per Discharge (**OP_DIS**)
- Emergency visits per Discharge (**EM_DIS**)
- Lab Tests per Discharge (**LAB_DISC**)
- Lab Tests per Lab Staff (**TSTLSTAF**)
- X ray Film per Patient (**X_PATIET**)
- X ray episodes per Discharge (**X_DISC**)
- X ray episodes per Radiology Staff (**X_RSTAF**)
- Number of surgical operations performed per discharge (**SURGDISC**)
- Total number of Surgery Types (**SURG_TYP**)
- Total number of Surgeries per Surgeon (**SURG_SGN**)
- Medical staff to bed ratio (**TMEDBED**)
- Discharges per Medical Staff (**DISCTMD**)

- Nurses to Bed ratio **(NURS_BED)**
- Discharge per Nurse **(DISC_NR)**
- Nurse to Medical staff ratio **(NURS_MD)**
- Non Medical Staff to bed ratio **(NMSTFBD)**
- Discharge per Non-medical staff **(DISNMSTF)**

A.2 Quality of Care Variables: Technical quality of care is measured in terms of 2 groups of measures. The first is outcome measures (e.g. death rate and maternity) and the second is surrogate measures (e.g. medical and nursing staff qualifications). The 13 quality of care variables selected from the available data, grouped by the three measures of quality, were:

A.2.1 Death Rate

- In hospital Mortality per Discharge **(MRI_DISC)**
- Perinatal mortality per 1000 Normal Born Alive **(PNMTNB)**

A.2.2 Maternity Outcome Variables (including Neonatal Deaths):

Maternity data records the newly delivered babies in terms of the outcome (i.e. born alive; born dead and dead after delivery) characterized by the type of delivery (i.e. normal, premature and cesarean section) and of the delivery measured.

- Dead after Delivery per 1000 Normal Born Alive **(DAD_NBA)**
- Premature Born Alive per 1000 Normal Born Alive **(PMA_NBA)**
- Premature Born Dead per 1000 Normal Born Alive **(PMD_NBA)**
- Caesarean Born Alive per 1000 Normal Born Alive **(CA_NBA)**
- Caesarean Dead during procedure per 1000 Normal Born Alive **(CDP_NBA)**

- Caesarean rate (Cesarean delivered babies as % of total delivered babies)(**CS_RATE**)
- Cesarean Section operations (as % of OBGYN Surgeries)(**CSOBG)**
- Premature Dead During Labour per 1000 Normal Born alive **(PMDDLNBA)**

A.2.3 Manpower

- Ratio of Consultants to total Medical Staff **(CONSLTMD)**
- Ratio of Consultant Surgeons to total Surgeons **(SGCT_SGN)**
- Ratio of registered Nurses to Total Nurses **(RN_TN)**

A.3 Organizational Structure Elements

The two sets of organizational structure elements selected were:

A.3.1 Quantitative

- Management Staff qualification measured by the proportion of management staff with a graduate degree **(ADG-TAD)**

A.3.2 Qualitative (survey questionnaire)

- Organizational Chart (**ORGCH1, ORGCH2, ORGCH3, ORGCH4**);
- Policies and Procedures (**POLCP1, POLCP2, POLCP3**);
- Job Descriptions (**JDISC**);
- Utilization review (**UTLZRV1, UTLZRV2**);
- Quality Management (**QM1, QM2**);
- Communication (**COM1, COM2, COM3**);
- Hospital Information System (**HIS1, HIS2, HIS3, HIS4**).

B. Independent variable

Given the purpose of the study the independent variable is the hospital's type of management categorized into three types:

Type 1: Full service contract management

Type 2: Comprehensive contract management

Type 3: Traditional management

C. Confounding Variables

Confounding variables, which may influence hospital performance, were also included in the analysis:

- **Hospital size** is measured by the number of available beds that are set up and staffed for use in the hospital. Hospital size is also dichotomized into 2 groups using the mode, which is 150 beds. The two groups are identified as group 1: equal to or below the mode (small hospitals); and group 2: above the mode (large hospitals).

- **Regional location** is defined as the geographical area within Saudi Arabia where the hospital is located. There are five broad regional categories: region 1 is Central, region 2 is Western, region 3 is Eastern, region 4 is Southern and region 5 is Northern region.

A major criticism of ratio analysis is that it only considers one performance indicator at a time. Further multivariate methods have therefore been adopted as well to help better understand the relationships between performance measures, and hence to improve the interpretation of the results of the ratio analysis.

Factor analysis is an analytical technique that attempts to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. It is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables.

Factor Analysis has therefore been used to find underlying principal components in each of the three dimensions of hospital performance. Once found, analysis of variance is again used to investigate the extent to which these principal components can be explained by type of management, after allowing for important confounding variables.

Discriminant analysis is typically used in situations where the analyst wishes to build a predictive model of group membership based on observed characteristics of each case. Chapter 5 therefore also investigates the extent to which **Discriminant Analysis** can be used to identify combinations of performance indicators that best characterize the differences among the types of management; and hence the extent to which this approach offers further insights into the determinants of hospital performance.

4.3.2 Phase 2

A particular feature of this work is the need to analyze multiple inputs and multiple outputs simultaneously. This is a situation for which Data Envelopment Analysis (DEA), has been specifically designed, and hence can be used to estimate the relative efficiency scores of the units.

Data Envelopment Analysis (DEA) is described and used in chapter 6 to estimate the relative efficiency scores of the 75 MOH hospitals. It compares each unit to the best performance among the group rather than to the average performance of the group. DEA also isolates less efficient units to further determine how their efficiency may be improved to the level of the more efficient units in the group. The inputs and outputs available from the MOH data set, and special software designed for DEA called " Frontier Analyst" are used to calculate the relative technical efficiency scores.

There are a number of theoretical and practical concerns about the application of DEA, which mean that it is important to generate and compare the results of a range of DEA models. This process and its associated results are therefore described. Two sets of DEA efficiency scores are then selected for the hospitals, one of which assesses hospital efficiency relative to the whole group, and the other assesses it relative to hospitals of similar size.

After calculating the relative efficiency scores for each hospital, the relationship between hospital technical efficiency and type of management and other hospital characteristics (size and regional location) are examined using ANOVA and appropriate non-parametric tests.

4.3.3 Phase 3

Phase three of the research brings together the results of phases one and two, and shows how they can be used in combination to address real issues related to CM and hospital performance in Saudi Arabia. Five example issues are presented. In one of these cases the results from the earlier phases are used directly. In the other 4 cases, further statistical analysis of the relationship between the earlier sets of results is required.

4.3.4 Methodology Overview

The methodological framework underpinning this research is summarized in figure 4.1. In particular, phases 1 and 2 aim to make sense of the multiple performance indicators in terms of independent variables and confounding factors, and in terms of their own interrelationships. Phase 3 then aims to show how this understanding can be used to inform decision making about real issues.

Figure 4.2 provides a diagrammatic overview of the processing and analysis of the MOH and questionnaire data sets used within the various phases of the research.

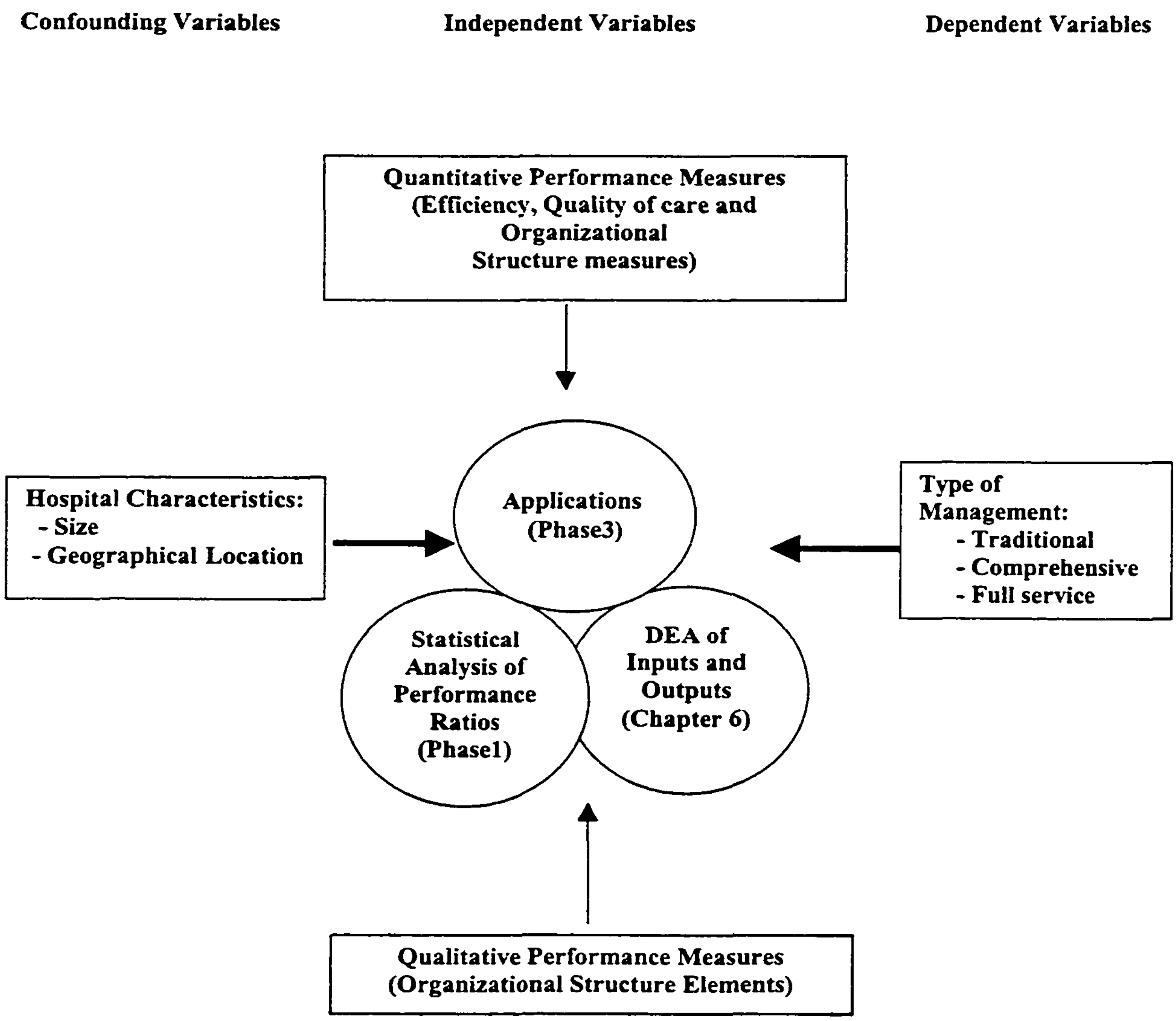

Figure 4.1 Study Methodological Framework

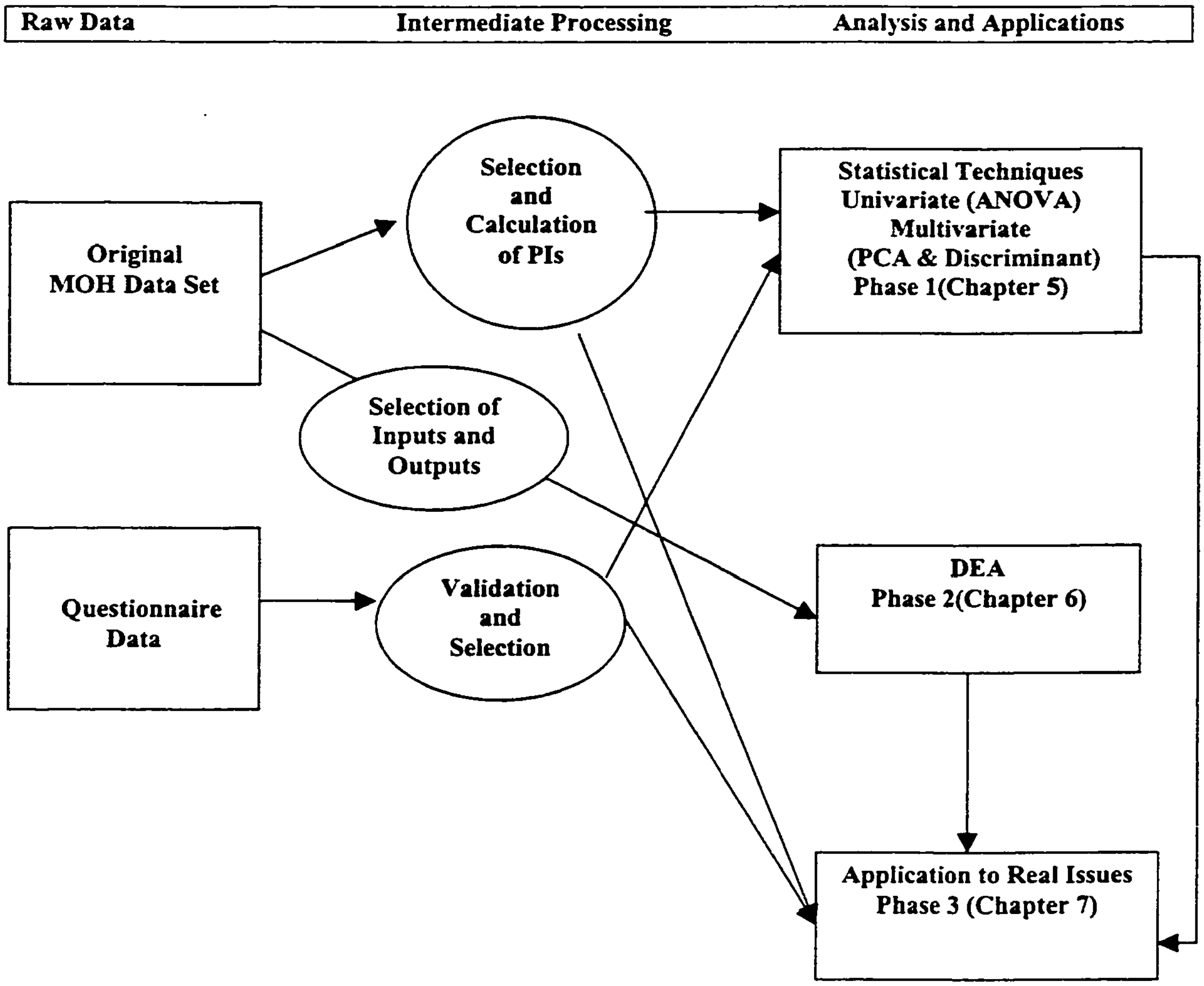

Figure 4.2 Study Data Process

4.4 Case Mix Adjustment

In order to use hospital output measures to compare the quality of care provided to patients and / or the efficiency of operation, homogeneity of the output measures, and indeed inputs, is required. According to Flood and Scott (1987c) the assumption that all patients are identical or that any differences among patients are distributed randomly among the hospitals must hold. In real life applications neither assumption is likely to be true. Flood and Scott (1987c) argued that hospitals do differ in the types of patients treated, and hence case mix can make a significant contribution to differences in the aggregate measures of type and mix of services provided and outcomes achieved. Therefore differences in patient health status need to be taken into account. Two ways to achieve this are by limiting the comparison to similar groups of patients, or by making adjustments for either service mix or case mix. The choice of which approach to use depends largely on the availability of data. Studies in the literature comparing hospitals' quality of care or efficiency have used service mix or case mix more frequently.

4.4.1 Possible Approaches

The terms Service Mix and Case Mix are widely used in the health literature and provide classifications designed to organize the health care outputs into manageable measures for reimbursement, planning, quality control, budgeting and research purposes (Hornbrook1982). The service mix approach involves analyzing the hospital outputs from the supply side, with the output being determined by the character and range of its facilities and services. In contrast the case mix approach concentrates on the demand side, with each hospital's caseload being determined by the need and demands of the population served, for example by specialty mix, ICD groupings or DRG groupings. Early studies in the United States used service mix in the absence of detailed diagnostic information, while the British and Canadian studies and the more recent studies in the US used case mix when relevant case mix data was available (Tatchel 1983).

While most researchers agree that case mix differences are a major source of variation in the hospital output, there is little agreement as to the best measure of this difference. Adjustment for case mix is particularly difficult to accomplish when it comes to hospitals over all quality of service or efficiency (Hebel et al 1982). Case mix measures developed are typically partial measures, designed to satisfy the requirements of particular research projects (Tatchel 1983). Hence many approaches have been used, but the most repeatedly applied in the literature are:

1. The aggregation of diagnostic data (e.g. into DRGs) to provide more detailed estimation of case mix differences. Where case types are defined in terms of diagnosis, prognosis, utilization, organ system, hospital department and patient characteristics (Hornbrook 1982).
2. The use of proxy variables to approximate case mix.

Although the first approach is generally recognized as preferable, it can only be used when good quality diagnostic data is available. When it is not available, as is the case in Saudi Arabian MOH hospitals, the literature suggests the approximation of case mix through the use of a proxy. Roemer et al (1968) used the average length of stay (after being corrected for demand on beds) as a proxy for case severity. Another approach, by Dubios et al (1987b), used the annual number of visits to the emergency room divided by the average daily census. A third approach used the percentage of hospital days spent in the intensive care unit (Shortell and Hughs 1988).

Average Length of Stay (ALOS) appears repeatedly in the literature as an indicator significantly related to case mix and complexity, however the evidence was found in studies that looked at the variations in ALOS. Many studies have found that the major determinants of Alos are the complexity and severity of the medical cases. Case mix refers to the types of patients treated, whereas case complexity refers to severity of illness within each of the disease categories. Garg et al (1978) found that among the 3 levels of severity for a total of 41 diagnostic codes level one had shorter length of stay. Lave and Leinhardt (1976) found that case mix and complexity explain 40% of the variation in ALOS. Rafferty (1972) found that variation in case mix and complexity accounted for 88% of the variation in ALOS. On the other hand Luke (1979) found that length of stay, proportion of cases with multiple diagnosis, proportion of cases over age 50 and case fatality rate are highly intercorrelated across 212 case types diagnostic group.

Alahmadi (1995) in studying the determinants of length of stay in some government hospitals in Saudi Arabia found that, demographic and clinical characteristics, physician characteristics and hospital characteristics determine length of stay, most frequently are patient's age, case severity, surgical procedure and physician's specialty.

In a study analyzing the hospital service consumption, mainly length of stay and radiology and laboratory services within six diagnostic groups, Riedel and Fitzpatrick (1964) found that patient characteristics (age, sex, existence of complications and surgery) were consistently the most important variables in explaining length of stay variations within diagnostic groups. They also found that for all diagnoses, the existence of complications significantly increased length of stay.

Roemer et al (1968) introduced the first overall hospital adjusted death rate model (Dubois et al 1987b). In analyzing the effect of a number of variables on the hospital crude death rate, they have found that the best measure of case severity is average length of stay, the longer the length of stay, the greater the average severity of illness. However they suggest that ALOS is also affected by the demand for hospital beds. The model is conceptually based on ALOS as a hospital case characteristic that applies to all hospital admissions, which reflects several factors contributing to case severity such as Age of Death, Socioeconomic Status and Diagnosis. The model described large differences in death rates among 33 Los Angeles County Hospitals by occupancy corrected ALOS alone (63% of the variation in the crude death rate).

The Roemer et al (1968) model for severity-adjusted death rates (SADR) used ALOS after being corrected for pressure on beds using the following the formula:

$SADR_i = 100DR_i - B\ (OCALOS_i - A)$

Where: DR_i - is the crude death rate for hospital i;

A - is the average OCALOS for all hospitals in the data set

B - is the regression coefficient for the influence of OCALOS on DR when regressing 100DR against $(OCALOS_i - A)$;

where $OCALOS_i = ALOS_i * (Occupancy_i / \text{Average occupancy rate})$

and: OCALOS – is occupancy adjusted ALOS for hospital i;

$ALOS_i$ - is average length of stay for hospital i;

$Occupancy_i$ - is occupancy rate for hospital I i;

Average occupancy rate - is the average for all hospitals in the data set.

The Roemer et al approach to case mix adjustment has been adopted, where possible, in this research. This includes a minor modification to their suggested formula for occupancy adjusted average length of stay (OCALOS). In particular, the average occupancy rate is assumed here to be 80% instead of the actual average of 68 %, and hence the adjustment is made so that hospitals with occupancy rate over 80

% will have an increase in their ALOS, whereas hospitals with less than 80 % occupancy rate will have a decrease in their ALOS. This is because the Ministry of Health hospital operational policy categorizes hospitals operating at 80% occupancy rate as fully occupied, i.e. it sees 80% occupancy as achievable without affecting ALOS. This belief is supported to some extent by figure 4.3, which shows evidence of wide ranging ALOS for occupancies less than 80%, but generally short ALOS for occupancies greater than 80%.

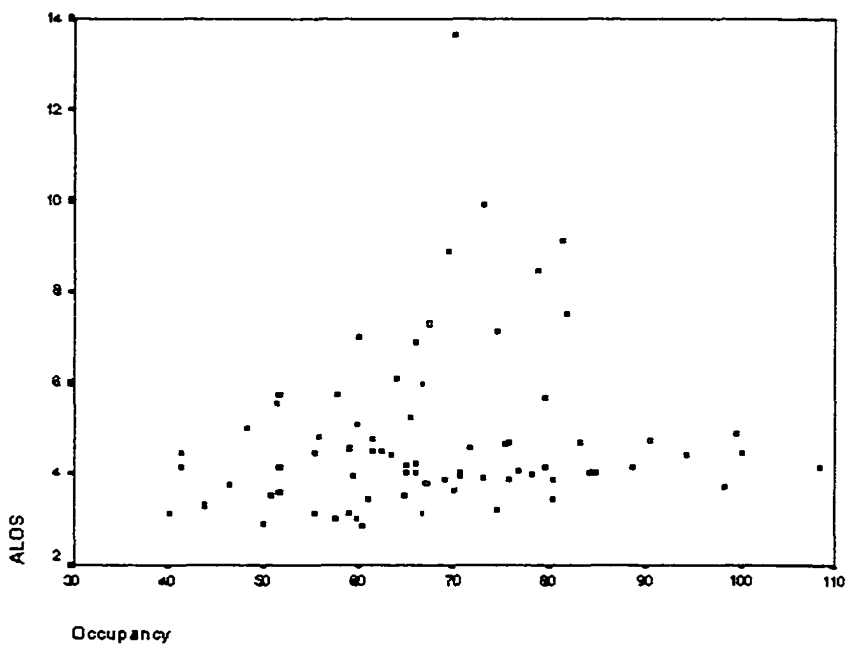

Figure 4.3: Scattergram of ALOS and Occupancy Rate

4.4.2 Adjusting Death Rate for Case Mix

Following the ideas in Roemer et al model, multiple regression has been used to explore the influence of a set of available variables on hospital death rates. The set included ALOS, OCALOS, percentage of consultants in the medical staff, emergency cases per discharge, lab tests per discharge, x-rays per discharge, major surgical operations per discharge, and number of surgical specialties. It was found that the crude death rate in the 75 hospitals in the data set had the highest correlation with the average length of stay, the coefficient being .811 and positive. ALOS explained 65.7% of the variation in crude death rate among the hospitals. In fact in this data set was slightly worse, its correlation with crude death rate was .788. Nevertheless, OCALOS was used in the adjustment computation to account for the demand on bed effect on the ALOS.

The scattergram in figure 4.4 shows the pattern of the relation ship between crude death rate and OCALOS that is similar for small and big hospitals.

The regression equation derived from the data set for adjusting crude death rate for case severity using OCALOS was:

Adjusted crude death rate (ADJMRIDI) = 100* crude death rate –

403*(OCALOS- 4.098).

This ADJMRIDI has been used instead of crude death rate in the remainder of the thesis.

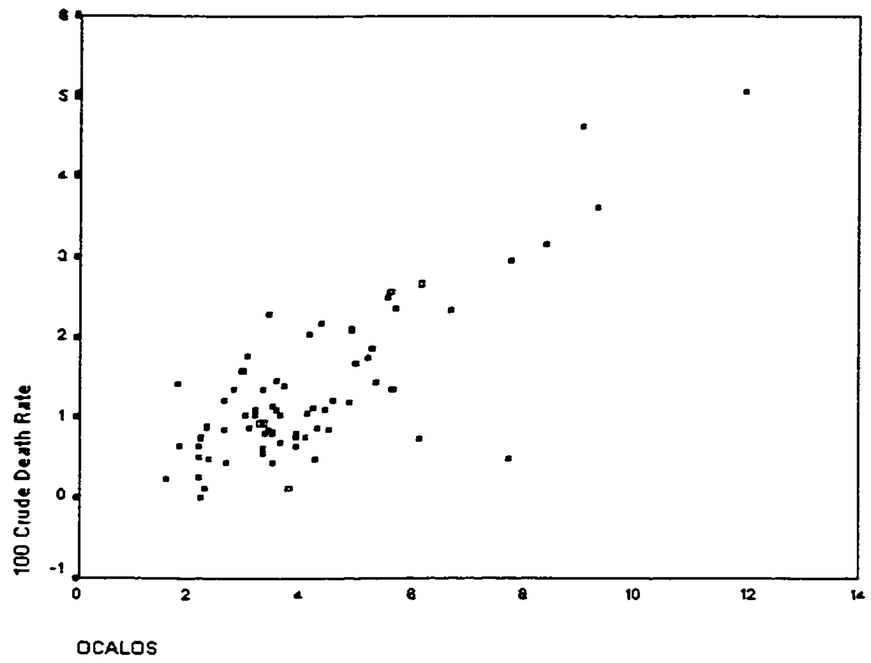

Figure 4.4: Scattergram of OCALOS and crude death rate

4.4.3 Adjusting Operating Efficiency Indicators for case mix

Following the ideas in the Roemer et al model, the possibility of adjusting the operating efficiency ratios using OCALOS has been explored.

Only 4 ratios were found to have significant relationships with OCALOS. These were:

- Major surgeries per discharge;
- Lab tests per discharge;
- X-ray per patient;
- X-ray per discharge.

The amount variations in these ratios explained by the OCALOS were 43.3 %; 40%; 28.2%; and 38.8% consecutively. Apparently, those ratios are related to length of stay. A patient who goes under a major surgery would be expected to stay longer relative to non-major procedure patients. In addition, the diagnostic procedures are expected to relate to length of stay where complex cases would stay longer and require more diagnostic procedures than non-complex cases. However, these measures may reflect other factors related to service intensity. For example, according to Berki et al (1984), a stay in special service units such as ICU is associated with more tests. Staff qualifications and experiences are also associated with more tests, where they found that surgical resident physicians are likely to order more tests. Nevertheless, because no more appropriate means are available from the data set. These ratios were adjusted using the Roemer et al (1968) model. Adjustment were made by the following equations:

- Adjusted major surgeries per discharge = major surgeries per discharge - .03461 (OCALOS- 4.098).
- Adjusted Lab tests per discharge = Lab tests per discharge – 8.01 (OCALOS- 4.098).
- Adjusted X-ray episodes per patient = X-ray per episodes patient – .114 (OCALOS- 4.098).
- Adjusted X-rays episodes per discharge = X-rays episodes per discharge - .941 (OCALOS- 4.098).

They were used along side the original ones in some parts of the later research.

Chapter Five: Statistical Analysis of Hospital Performance

The purpose of this chapter is to use univariate and multivariate statistical methods to investigate the extent to which the three dimensions of hospital performance (efficiency, quality of care and organizational structure) can be explained by type of management. There are four main sections in this chapter. The first section presents descriptive analyses of the dependent variables by the independent and confounding variables. The second section presents the univariate statistical analysis, the third section uses factor analysis, and the fourth section uses discriminant analysis.

5.1 Descriptive analysis

The initial task in any research endeavor is to identify the distributional characteristics of each of the variables to be used in the required statistical analyses (Nie et al 1975). Statistical techniques and inference demand an understanding of the distributional variability and the central tendency of the variables of interest.

Of the 75 hospitals included in the study, 9.3 % are full service contract managed (type 1), 45.3 % are comprehensive contract managed (type 2) and 45.3 % are traditionally managed (type 3).

Table 5.1 presents the distribution of the study hospitals by type of management, size and regional location. It reveals a heavy concentration of full service contract management in the large hospitals (>150 beds), comprehensive contracts are evenly distributed, while traditional management is concentrated in the small hospitals (=< 150 beds). Table 5.1 also reveals that regions 3 and 5 have the lowest numbers of hospitals of all types of management. This is partly because a major portion of the hospitals excluded because they were new or newly engaged in contract management are located in these two regions.

	Type of Mgmt			
	Full Service Contract (1)	Comprehensive Contract (2)	Traditional (3)	Total
Bed category				
Small (=< 150)	1	16	21	38
Large (> 150)	6	18	13	37
Total	7	34	34	75
Regional Location				
Central (1)	1	8	9	18
Western (2)	3	7	9	19
Eastern (3)	-	5	1	6
Southern (4)	3	11	9	23
Northern (5)	-	3	6	9
Total	7	34	34	75

Table 5.1: Distribution of hospitals by type of management and confounding variables

Means, standard deviations, coefficient of variations, minimum and maximum values of the performance ratios selected for statistical analyses are shown in table 5.2. They are grouped according to the main theoretical constructs, identified in chapter 2, for which each variable is the operational indicator (operational efficiency, quality of care and organizational structure elements). In addition, sub-groups have been introduced to structure the descriptive analyses that follow.

In general the data exhibits relatively low coefficients of variation among the study hospitals for the bed throughput operating efficiency indicators [average length of stay (ALOS), Occupancy rate (OCC_R) and bed turn over rate (BTOR)]. However the data exhibits relatively high coefficients of variation among the hospitals for staff productivity indicators, in particular radiology and laboratory staff and surgeons productivity (X-RSTAF, TSTLSTAF and SURG_SGN).

On the quality of care side, there is a relatively high variation on the perinatal mortality rate (PNMTBA) and medical staff qualifications, i.e. proportion of consultants among medical and surgical staff (CONSLTMD and SGCT_SGN). Maternity data also exhibits relatively high variations among hospitals on the caesarean delivered dead during procedure (CDP_NBA), premature born dead (PMD_NBA), premature born dead during labour (PMDDLNBA) and dead after delivery rates (DAD_NBA).

	Construct /Variables	N	Mean	Std. Deviation	C.V.	Min.	Max.
Bed Throughput	ALOS	75	4.78	1.81	0.38	2.88	13.62
	OCC_R	75	67.76	14.40	0.21	40.00	108.33
	BTOR	75	54.63	16.84	0.31	18.23	94.01
	BTOI	75	2.50	1.51	0.61	-0.32	6.33
Outpatient Mix	OP_DIS	75	10.95	6.29	0.57	3.66	34.83
	EM_DIS	75	6.62	3.58	0.54	0.00	15.25
Surgical Activities	SURG_TYP	75	13.12	2.65	0.20	6.00	18.67
	SURGDISC	75	0.32	0.15	0.47	0.12	0.79
Diagnostic Procedures	LAB_DISC	74	37.13	23.09	0.62	12.45	118.84
	X_PATIET	75	1.65	0.40	0.24	1.05	3.42
	X_DISC	75	4.93	2.84	0.58	1.78	15.14
Staff Availability	TMEDBED	75	0.39	0.15	0.38	0.16	0.92
	NURS_BED	75	0.91	0.26	0.28	0.41	1.61
	NMSTFBED	75	1.84	0.72	0.39	0.45	3.95
	NURS_MD	75	2.50	0.74	0.30	1.15	5.02
Staff Productivity	DISCTMED	75	156.77	73.44	0.47	20.84	399.44
	SURG_SGN	75	232.27	157.59	0.68	50.10	942.44
	DISC_NR	75	64.90	26.85	0.41	17.25	137.04
	DISNMSTF	75	36.25	21.60	0.60	8.29	111.20
	X_RSTAF	75	2052.44	1620.97	0.79	750.91	13096.67
	TSTLSTAF	74	17786.55	15042.48	0.85	4509.06	120661.75
Mortality	ADJMRIDI	75	1.29	0.56	0.44	-0.96	2.63
	PNMTBA	75	11.6	11.1	0.96	0.00	50
Staff Qualifications	CONSLTMD	75	0.11	0.12	1.02	0.00	0.49
	SGCT_SGN	75	0.23	0.23	0.99	0.00	0.75
	RN_TN	75	0.94	0.13	0.14	0.02	1.00
Maternity	CSOBG	75	23	13	0.55	0.00	44
	CS_rate	75	8.1	4.62	0.57	0.00	18
	CA_NBA	75	92	57.6	0.63	0.00	240
	PMA_NBA	75	33	28	0.85	0.00	150
	CDP_NBA	75	0.2	0.7	3.5	0.00	10
	PMD_NBA	75	3.3	5.3	1.6	0.00	40
	PMDDLNBA	75	.5	1.1	2.2	0.00	10
	DAD_NBA	75	5.5	6.8	1.2	0.00	40
	Organizational Elements						
Administrative Staff Qualifications	ADG_TAD	75	0.17	0.15	0.86	0	0.72

Table 5.2: Descriptive statistics for the dependent variables.

5.1.1 Contract Management

As shown in table 5.3, CM hospitals are on average larger in size, with an average of 332 beds for full service contracts (type 1), 226 beds for comprehensive contracts (type 2), and 185 beds for traditional management (type 3).

A. Operating Efficiency

- Bed Throughput

In terms of bed throughput, type 2 hospitals are busiest with a mean occupancy rate of 71% compared with 64% and 65% for type 1 and 3. However, type 3 hospitals have lower average lengths of stay (ALOS) and higher bed turn over rates (BTOR).

- Outpatient Mix

Traditionally managed hospitals are seeing on average about twice as many outpatient visits per discharge (OP_DIS) as contract managed hospitals, while the three groups have very similar average emergency room visits per discharge (EM_DIS).

- Surgical Activities

In terms of surgical activities, all three types of management offer a similar average numbers of surgical specialties (SURG_TYP). However the number of surgical operations per discharge (SURGDISC) is about 40% higher at the traditionally managed hospitals.

	Construct/ Variables	Type of Management					
		1		2		3	
		N=7		N=34		N=34	
		Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**
	BEDS	332.43	155.21	226.39	154.61	183.64	163.91
Sub-groups	**Operating Efficiency**						
Bed Throughput	ALOS	5.44	1.32	5.02	2.23	4.41	1.33
	OCC_R	63.86	8.93	71.04	15.09	65.29	14.21
	BTOR	43.82	9.23	55.59	17.88	55.89	16.53
	BTOI	3.08	0.93	2.27	1.50	2.60	1.61
Outpatient Mix	OP_DIS	7.35	1.47	8.61	3.25	14.04	7.71
	EM_DIS	7.70	3.37	6.46	3.78	6.56	3.47
Surgical Activities	SURG_TYP	14.76	3.46	13.84	2.14	12.06	2.59
	SURGDISC	0.28	0.06	0.28	0.14	0.38	0.16
Diagnostic Procedures	LAB_DISC	46.48	13.61	38.14	25.98	34.11	21.35
	X_PATIET	1.78	0.42	1.73	0.46	1.54	0.31
	X_DISC	4.76	1.41	4.83	3.20	5.07	2.72
Staff Availability	TMEDBED	0.53	0.22	0.40	0.14	0.35	0.12
	NURS_BED	1.17	0.36	0.92	0.24	0.86	0.22
	NMSTFBED	2.22	0.36	2.10	0.68	1.49	0.68
	NURS_MD	2.47	1.21	2.38	0.63	2.62	0.73
Staff Productivity	DISCTMED	85.94	29.14	153.14	67.00	174.99	77.67
	SURG_SGN	169.21	83.21	193.00	104.82	284.53	195.44
	DISC_NR	42.24	20.44	64.36	25.14	70.12	27.78
	DISNMSTF	19.93	4.54	29.67	14.90	46.18	24.85
	X_RSTAF	1335.94	397.62	1988.08	1129.62	2264.31	2104.25
	TSTLSTAF	15584.99	4176.48	17360.74	10852.75	18692.25	19732.21
	Quality of Care						
Mortality	ADJMRIDI	1.42	0.44	1.32	0.58	1.23	0.59
	PNMTNB	13.5	6.5	16.9	16.3	9.9	9.2
Staff Qualifications	CONSLTMD	0.28	0.17	0.17	0.08	0.03	0.04
	SGCT_SGN	0.47	0.27	0.36	0.18	0.06	0.11
	RN_TN	0.75	0.09	0.96	0.06	0.96	0.17
Maternity	CSOBG	36	6	26	12	18	11
	CS_RATE	12.4	1.77	9.2	4.75	6.1	3.93
	CA_NBA	147	25.3	108	60.7	64	43.5
	PMA_NBA	43	54	38	26.7	25.8	19.9
	CDP_NBA	.97	2	.15	.32	.06	.14
	PMD_NBA	1.8	1.3	4.36	7.2	2.6	3
	PMDDLNBA	1.1	2.3	.6	1.3	.3	.45
	DAD_NBA	10.1	4.7	5.5	7.3	4.6	6.4
	Organizational Elements						
Administrative Staff Qualifications	ADG-TAD	.35	.13	.2	.14	.11	.12

Table 5.3: Descriptive statistics for the performance ratios by type of management.

- Diagnostic Procedures

CM hospitals are on average doing more laboratory tests per discharge (LAB_DISC), while very close to traditional managed hospitals on Xray episodes per discharge (X_DISC). However traditonally managed hospitals tend to have less x-rays per patient (X_PATIET).

- Staff Availability

CM tends to provide hospitals with higher staffing levels, as indicated by medical, nursing and nonmedical staff bed ratios (TMEDBED, NURS_BED and NMSTFBED).

- Staff Productivity

On the productivity side, traditionally managed hospitals tend on average to have higher staff productivity for all staff groups: medical (DISCTMED), nurses (DISC_NR), nonmedical staff (DISNMSTF), radiology staff (X_RSTAF) and laboratory staff (TSTLSTAF).

B. Quality of Care

- Mortality

Quality of care indicators show that on average traditionally managed hospitals had lower case mix adjusted death rate (ADJMRIDI) and perinatal mortality (PNMTNB).

- Staff Qualifications

CM hospitals on average had higher proportions of consultants among medical staff (CONSLTMD) and among surgeons (SGCT_SGN). The proportions of nurses who are registered (RN_TN) are similar in the comprehensive contract managed and traditionally managed hospitals, and both are higher than in the full service contract managed hospitals. This may be attributed to the MOH policy of recruiting registered nurses for all nursing positions appointed by the MOH. In the full service contract managed hospitals a more structured nursing organization is defined by the contract specifications, and hence nursing supervision, staff nurses and assistance nurses positions are well defined, and the required qualifications for each level are stated.

- Maternity

Maternity data shows that the percentage of the babies delivered by caesarean-section (CS_RATE) is on average higher at the contract managed hospitals with a means of 12.4% and 9.2% compared with 6.1 % for traditionally managed hospitals. Caesarean section operations as a percentage of obstetric and gynaecology operations (CSOBG) are on average higher at the CM hospitals with means of 36% and 26% compared to a mean of 18% for traditional management. The rates for caesarean born alive (CA_NBA), premature born alive (PMA_NBA), caesarean born dead during procedure (CDP_NBA), premature born dead during labor (PMDDLNBA) and babies dead after normal delivery are on average higher at the contract managed hospitals, which may be due to these hospitals having more abnormal deliveries (caesarean and premature). On the other hand premature born dead (PMD_NBA) is lowest in the full service contract managed hospitals, while it is highest at the comprehensive contract managed hospitals.

C. Organizational Structure Elements (Quantitative Measures)

- Administrative Staff Qualifications

In terms of administrative staffing, contract managed hospitals on average have a higher proportion of administrative staff with graduate degrees (ADG_TAD). Nearly 35 % of the administrative staff in full service contract managed hospitals held graduate or postgraduate degrees compared with 20% for comprehensive contract managed hospitals and 11% for the traditionally managed hospitals.

5.1.2 Hospital Size

Means and standard deviations of the performance ratios by hospital size groups are shown in table 5.4.

A. Operating Efficiency

- Bed Throughput

Average small hospitals tend to have higher bed throughputs with lower average lengths of stay (ALOS), lower occupancy rates (OCC_R), lower bed turn over intervals (BTOI), and higher bed turn over rates (BTOR).

- Outpatient mix

Small hospitals are, on average, seeing about 23 % more outpatient visits per discharge (OP_DIS) than large hospitals, while the two groups have very similar average emergency room visits per discharge (EM_DIS).

- Surgical Activities

Large hospitals tend to provide more surgical specialties (SURG_TYP) with an average of 14.63 compared with 11.65 for the small hospitals. Nevertheless, they have similar numbers of surgical operations per a discharge (SURGDISC).

- Diagnostic Procedures

Large hospitals, on average, tend to perform about twice as many diagnostic procedures per patient (LAB_DISC; X_DISC) as in small hospitals, which maybe related to case mix differences between small and large hospitals. The two groups are very close on average x-rays per patient (X_PATIET).

- Staff Availability

Large hospitals tend to have higher medical and nursing staff to bed ratios (TMEDBED; NURS_BED), while non-medical staff to bed ratios (NMSTFBED) tend to be higher in the small hospitals.

- Staff Productivity

Most staff productivity ratios (DISCTMED; SURG_SGN; DISC_NR; DISNMSTF; X_RSTAF) are on average higher in the small hospitals. However laboratory staff productivity (TSTLSTAF) is higher in the large hospitals.

		Hospital Size			
		Small (=< 150 beds)	(N=38)	Large (>150 beds)	(N= 37)
		Mean	Std. Deviation	Mean	Std. Deviation
	BEDS	105.07	31.04	331.77	162.88
Sub-groups					
Bed Throughput	ALOS	3.93	.63	5.66	2.18
	OCC_R	64.46	13.05	71.16	15.08
	BTOR	59.18	11.89	49.94	19.82
	BTOI	2.37	1.24	2.63	1.76
Outpatient Mix	OP_DIS	12.05	7.02	9.83	5.29
	EM_DIS	6.98	3.83	6.25	3.31
Surgical Activities	SURG_TYP	11.65	1.84	14.63	2.51
	SURGDISC	.30	.16	.35	.14
Diagnostic Procedures	LAB_DISC	25.42	9.92	49.49	26.49
	X_PATIET	1.46	.19	1.85	.47
	X_DISC	3.70	1.25	6.20	3.42
Staff Availability	TMEDBED	.36	.12	.42	.16
	NURS_BED	.83	.20	1.00	.28
	NMSTFBED	1.90	.76	1.77	.69
	NURS_MD	2.43	.67	2.57	.80
Staff Productivity	DISCTMED	175.70	66.85	137.33	75.68
	SURG_SGN	241.29	185.79	223.01	124.08
	DISC_NR	74.96	20.71	54.57	28.71
	DISNMSTF	36.89	18.25	35.59	24.81
	X_RSTAF	2173.30	2106.50	1928.31	899.55
	TSTLSTAF	14194.09	6684.95	21578.58	19897.30
	Quality of Care				
Mortality	ADJMRIDI	1.20	.53	1.38	.59
	PNMTNB	13	12.2	13.9	14.1
Staff Qualifications	CONSLTMD	.07	.09	.15	.12
	SGCT_SGN	.16	.22	.31	.23
	RN_TN	.97	.05	.91	.18
Maternity	CSOBG	24	10	22	15
	CS_RATE	8.2	3.87	7.9	5.33
	CA_NBA	92.4	49.8	91.8	65.4
	PMA_NBA	34	19.7	32.1	34.8
	CDP_NBA	.105	.24	.27	1
	PMD_NBA	3.3	3.6	3.3	6.7
	PMDDLNBA	.45	.94	.5	1.3
	DAD_NBA	5.3	5.9	5.8	7.6
	Organizational Elements				
Administrative Staff Qualifications	ADG-TAD	.16	.13	.19	.17

Table 5.4: Dependent variables descriptive statistics by hospital size groups

B. Quality of Care

- Mortality

Mortality indicators revealed that, on average, small hospitals are lower on case mix adjusted death rate (ADJMRIDI) and perinatal mortality (PNMTNBA).

- Staff Qualifications

Large hospitals tend to have higher proportions of consultants among medical staff and among surgeons (CONSLTMD; SGCT_SGN), while they have lower proportions of registered nurses among the total nurses (RN_TN).

- Maternity

The maternity data reveals that the two hospital size groups have very similar performance levels in all maternity indicators other than for the small hospitals having less than half the percentage of caesarean born dead during procedure (CDP_NBA) average rate of the large hospitals.

C. Organizational Structure Elements

- Administrative Staff Qualifications

As expected, large hospitals on average have higher proportions of administrative staff with graduate degrees (ADG-TAD). Nearly 19 % of the administrative staff in large hospitals held a graduate degree compared with 16% for small hospitals.

5.1.3 Regional Location

Performance indicator means and standard deviations by regional location are provided in table 5.5. Region 3 hospitals tend to be the largest with a mean of 305.7 beds while region 4 hospitals tend to be on average the smallest in size with a mean of 174.6 beds, followed by region 5 with a mean of 200 beds.

A. Operating Efficiency

- Bed Throughput

Hospitals in region 5 tend to be busiest with the highest occupancy rate (OCC_R), highest BTOR and lowest BTOI. Region 2 hospitals tend to have the highest ALOS and the highest BTOI, and hence the lowest BTOR.

- Outpatient Mix

Region 2 hospitals have on average the highest outpatient visits per discharge (OP_DIS) and the lowest emergency visits per discharge (EM_DIS). Recall that region 2 hospitals have the largest ALOS, which indicates that inpatient cases in region 2 hospitals may be of a more long term care nature. Region 3 hospitals have a more balanced mix with very close average outpatient visits per discharge and emergency room visits per discharge. The data on the regional level suggests that there is a trade-offs between the outpatient and emergency services in the hospitals with the increase in one matched with the decrease of the other.

- Surgical Activities

Region 3 hospitals, as expected at a large hospitals, tend to offer a slightly wider range of surgical specialties (SURG_TYP). However the average number of surgical operations per discharge (SURGDISC) is highest in region 1, and lowest in region 4.

- Diagnostic Procedures

Diagnostic procedures data revealed that hospitals in regions 2 and 3 are on average doing markedlly more laboratory tests per discharge (LAB_DISC) and Xrays per discharge (X_DISC).

- Staff Availability

Staffing data revealed that, on average, region 3 hospitals are highly staffed compared to the other regions, in terms of medical staff to bed ratios (TMEDBED), nurses to bed ratios (NURS_BED) and non-medical staff to bed ratios (NMSTFBED). In fact region 2 has the highest medical staff to bed ratio. In other respects, the data revealed relatively similar staffing levels.

- Staff Productivity

On the productivity side, regions 4 and 5,which tend to have smaller hospitals, are generally the most productive.

B. Quality of Care

- Mortality

Quality of care indicators revealed that on average hospitals in regions 4 and 5 are lower in case severity adjusted death rate (ADJMRIDI). However the two regions are on average higher in perinatal mortality (PNMTNB).

- Staff Qualifications

Regions 2 and 5 hospitals have on average lower proportions of consultants among medical staff and among surgeons (CONSLTMD; SGCT_SGN). Registered nurses proportions of the total nurses (RN_TN) are over 94% in all regions except region 1 with 89%. However the ratio is 98% in regions 3 and 5, where none of the hospitals are full service contract managed.

- Maternity

Maternity data shows that the percentage of babies delivered by caesarean section (CS-RATE) is on average lower in region 2 with high variations among the hospitals in the region (coefficient if variation of 0.81). caesarean-section operation as a percentage of obstetric and gynecology operations (CSOBG) is on average higher in regions 1,4 and 5 where they are on average smaller in size. Maternity data also show that the rate of caesarean born alive (CA_NBA) is on average higher at regions 1,4 and 5 hospitals. However, the caesarean born dead during procedure rate (CDP_NBA) is on average higher in region 4 and lower in region 5. Premature born dead rate (PMD_NBA) is highest at region 4 hospitals. Premature born dead during procedure (PMD_NBA) is on average lowest at region 5 hospitals and highest at region 3 hospitals. Dead after delivery normal born babies rate (DAD_NBA) is highest in regions 4 and 5, while it is lowest at regions 2 and 3 hospitals, which tend to be large hospitals.

C. Organizational Structure Elements

- Administrative Staff Qualifications

Regions 5 and 4 have the highest proportions of administrative staff with graduate degrees (ADG_TAD) (.23 and .22 respectively).

		REGIONS									
		1 (N=18)		2 (N=19)		3 (N=6)		4 (N=23)		5 (N-9)	
		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Sub-groups	**Operating Efficiency**										
Bed Throughput	Beds	221.02	192.41	244.21	197.94	305.72	149.21	174.59	121.28	199.96	99.38
	ALOS	4.49	1.36	5.31	2.71	5.10	1.05	4.54	1.55	4.68	1.22
	OCC_R	62.50	11.97	63.65	10.28	75.06	22.11	68.46	15.09	80.33	11.00
	BTOR	52.04	13.41	49.09	16.68	55.49	24.40	57.48	17.71	63.61	13.31
	BTOI	2.84	1.39	2.97	1.29	2.41	2.30	2.36	1.57	1.19	0.71
Outpatient Mix	OP_DIS	10.03	3.85	12.59	7.75	8.96	4.03	10.60	5.53	11.59	9.62
	EM_DIS	7.30	3.28	4.94	3.50	8.02	4.81	7.42	3.59	5.85	2.49
Surgical Activities	SURG_TYP	13.02	2.19	12.35	2.72	15.44	2.61	13.39	2.20	12.70	3.81
	SURGDISC	0.37	0.14	0.32	0.15	0.34	0.16	0.29	0.16	0.33	0.16
Diagnostic Procedures	LAB_DISC	32.35	15.94	50.17	34.07	40.13	13.28	31.20	16.87	31.80	16.12
	X_PATIET	1.60	0.35	1.62	0.39	1.69	0.36	1.72	0.49	1.62	0.38
	X_DISC	4.81	2.82	5.67	4.27	5.72	2.81	4.59	1.62	3.95	1.12
Staff Availability	TMEDBED	0.37	0.09	0.46	0.22	0.43	0.09	0.35	0.10	0.34	0.14
	NURS_BED	0.98	0.21	0.94	0.30	1.16	0.20	0.81	0.20	0.81	0.27
	NMSTFBED	1.86	0.75	1.90	0.65	2.10	1.02	1.86	0.69	1.41	0.68
	NURS_MD	2.74	0.63	2.25	0.93	2.79	0.67	2.39	0.61	2.57	0.74
Staff Productivity	DISCTMED	152.35	62.85	125.65	62.65	129.65	55.47	170.95	75.13	213.18	90.40
	SURG_SGN	246.26	110.55	184.01	139.20	266.00	160.17	219.72	180.36	315.79	198.83
	DISC_NR	55.17	18.44	59.25	29.20	47.49	16.93	73.73	24.69	85.36	31.01
	DISNMSTF	34.28	19.62	30.46	17.58	29.61	14.16	37.17	24.25	54.48	23.70
	X_RSTAF	2370.21	2787.66	1456.48	477.92	2018.47	545.47	2332.80	1421.12	1981.19	483.98
	TSTLSTAF	13842.54	4847.67	22301.40	24720.12	15475.86	5158.13	17576.43	12517.10	17782.40	10475.61

Table 5.5: Dependent variables descriptive statistics by regions.

		REGIONS									
		1(N=18)		2(N=19)		3(N=6)		4(N=23)		5(N-9)	
		Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Sub-groups	**Quality of Care**										
Mortality	ADJMRIDI	1.31	0.44	1.53	0.54	1.32	0.42	1.17	0.51	1.02	0.90
	PNMTNB	.0087	.0086	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.02
Staff Qualification	CONSLTMD	0.12	0.13	0.10	0.11	0.12	0.05	0.13	0.13	0.08	0.11
	SGCT_SGN	0.26	0.26	0.20	0.19	0.30	0.20	0.26	0.26	0.16	0.23
	RN_TN	0.89	0.24	0.94	0.09	0.98	0.03	0.95	0.07	0.98	0.02
Maternity	CSOBG	25	13	19	15	15	11	24	11	28	9
	CS_RATE	8.9	4.36	6.39	5.15	7.27	4.03	8.93	4.79	8.33	3.61
	CA_NBA	103	55	73	60	71	46.7	107	62.8	85.8	42
	PMA_NBA	34	22	25	27	40	31	35.6	30.4	35.7	35.5
	CDP_NBA	0.12	0.3	0.15	0.3	0.17	0.27	0.33	1.3	0.05	0.07
	PMD_NBA	2.9	2.9	2.5	4.3	3.2	3.1	4.6	8.1	2.7	3.3
	PMDDLNBA	0.5	1.2	0.36	0.9	0.8	0.9	0.6	1.5	0.1	.23
	DAD_NBA	5	3.9	3.8	4.2	3.9	7.7	7.6	9.6	6	6
	Organizational Elements										
Administration Staff Qualifications	ADG_TAD	0.12	0.13	0.16	0.12	0.13	0.08	0.22	0.14	0.23	0.24

Table 5.5 continued

5.1.4 Summary

In summary the study hospitals tend to have relatively low variations in bed throughput, but vary relatively widely in staff productivity and medical staff qualifications. Other operating efficiency indicators tend to have more moderate variations. There are also relatively high variations in some quality measures; for example, perinatal mortality and maternity data.

A. Type of Management

The patterns for performance indicators by type of management are summarised in table 5.6. In general traditional hospitals tend to be small, have less complex cases, have limited scope of services and higher staff productivity, whereas CM hospitals tend to be large, highly staffed, have more services and have more complex cases.

	Traditional Management	**Contract Management**
- Size	On average small	On average large
Operating Efficiency		
- Bed Throughput	Perform better on most of the indicators	Comprehensive contract have highest average occupancy rate.
- Outpatient Mix	Higher in outpatient Activity	
- Surgical Activities	More surgical oriented, performing 40% more surgeries per patient	On average provide more surgical specialties
- Staff Availability		Tend to have higher staff to bed ratios
- Staff Productivity	Tend to have higher staff productivity	
Quality of Care		
- Mortality	Lower mortality rates	
- Staff Qualifications		Higher medical and surgical staff qualifications
- Maternity		Higher caesarean- section rate
Organizational Structure		
-Administrative Staff Qualifications		Higher proportion of administrative staff with graduate degrees

Table 5.6: Summary of main patterns for PIs by type of management.

B. Hospital Size

The pattern of operating indicators across the two hospital size groups revealed that small hospitals tend to have higher bed throughput, higher outpatient mix and higher staff productivity. However there are a number of indicators that are related to larger hospital size (i.e. diagnostic procedures, number of surgical specialties and staffing levels) which may indicate more complex cases in the large hospitals.

On the quality of care side, small hospitals tend to have lower mortality rates, whereas, as expected, large hospitals tend to have higher levels of medical and surgical staff qualifications.

C. Regional Location

At the regional level, it was found that region 5, which tended to have small hospitals, performed better in terms of bed throughput. The region tends to have lower death rate, but higher perinatal mortality rate. This region tends to be the lowest in medical staff qualification levels.

Outpatient mix data on the regional level revealed a trade-off between outpatient services and emergency services with the increase in one matched with the decrease of the other.

Regions 2 and 3, which tended to have large hospitals, are doing markedlly more diagnostic procedures. However Region 3 tended to have highest number of surgical specialties. In addition, those two regions tended to have higher staffing levels and lower staffing productivity.

Clearly some of the apparent patterns identified in these descriptive analyses may not be statistically significant, or may be better understood if considered together. The remainder of this chapter investigates these sorts of questions.

5.2 Univariate Analyses

One method, which can be used to analyze multiple inputs and multiple outputs relations, is to analyze a number of such relationships between different inputs and outputs (Sherman 1981). It is the most commonly used method in studying hospital performance, and comes from the finance and accounting disciplines (Ehreth 1994). In this section, the univariate GLM procedure is used to undertake analysis of variance (ANOVA) and regression analyses to investigate the effects of the independent variable (type of management) and confounding factors (hospital size and regional location) on the performance ratio indicators. In the analyses, which follow, full service and comprehensive contract managed hospitals are combined into one group (i.e. contract managed hospitals) to avoid statistical problems associated with the small number of full service contract managed hospitals.

5.2.1 Advantages and Limitations of Ratio Analysis

Ratio analysis involves the use of various ratios to explore the relationships that are abnormal to the general norms of group (Sherman 1984). Hence, it is useful in identifying which aspects of a hospital's performance are out of the line with the norm. Sherman (1981) argues that ratio analysis requires three phases. The first is identifying a comparable group of hospitals. Second is identifying various input-output relationships, which are believed to be of primary importance, and calculating their values for each hospital. Finally, the set of ratios is compared across all hospitals in a group to determine which hospitals are above or below average for each of the ratios. Based on this evaluation, hospitals below or above the group norm may be required to explain their high or low ratios.

The main advantages of ratio analysis are that it relies on simple mathematical concepts, it can be useful in identifying extremely good or poor operating levels (Sherman 1984); and it is a methodology familiar to managers (Sherman 1981).

However, it also has some limitations. By definition, each ratio is limited to one output and one input and hence the process cannot easily accommodate the multi-input / multi-output nature of the hospital industry, nor can it incorporate any mechanism which explicitly relates the ratios used to each other (Sherman 1981). Also, while comparisons can be made to group averages, an average is rarely an optimum, and hence the comparison may not be able to distinguish the best performing hospitals from poor performing hospitals (Ehreth 1994).

5.2.2 Operating Efficiency Ratios

Table 5.7 presents a summary of the ANOVA investigations into the relationships between the 21 operating efficiency indicators and type of management when hospital size and regional location were accounted for.

Of the 21 indicators, 7 differed significantly ($p<.05$) by type of management, 7 differed significantly by size, and 5 differed significantly by regional location. In addition there were significant interactions, as noted in the right hand column of table 5.6.

No significant differences were found on bed throughput measures. However there are significant differences ($p< .01$) on outpatient mix (OP_DISC) even after being adjustment for case severity, surgical activity (SURGDISC), nursing and non-medical staff availability (NURS_BED and NMSTFBED) and non-medical staff productivity (DISNMSTF). Significant differences but less so ($p\leq .05$), were found on diagnostic procedures (X_DISC) even after adjustment for case severity, medical staff availability (TMEDBED) and surgical staff productivity (SURG_SGN).

	Type of Mgmt	Hospital Size	Region	Interactions
Dependent	P-value	P-value	P-value	
ALOS	0.578	0.000	0.422	
OCC_R	0.209	0.104	0.025	
BTOR	0.655	0.622	0.178	
BTOI	0.397	0.266	0.033	
OP_DIS	0.001	0.56	0.678	
EM_DIS	0.33	0.217	0.079	
SURG_TYP	0.085	0.000	.194	
SURGDISC	0.005	0.06	0.693	
LAB_DISC	0.458	0.000	0.006	Bed category by region (p=0.031)
X_PATIET	0.261	0.000	0.307	Type of Mgmt by Bed category at (p=0.022)
X_DISC	0.021	0.000	0.08	Type of Mgmt by Bed category (p=0.028)
TMEDBED	0.03	0.359	0.095	
NURS_BED	0.012	0.119	0.004	Type of Mgmt by Region (p= 0.009)
NMSTFBED	0.001	0.061	0.646	Bed category by region (p=0 .004)
NURS_MD	0.22	0.51	0.142	The 3 way (type by size by region) (p=0.007)
DISCTMED	0.102	0.083	0.037	
SURG_SGN	0.055	0.667	0.327	
DISC_NR	0.344	0.003	0.003	Bed category by region (p=0 .047)
DISNMSTF	0.001	0.561	0.155	
X_RSTAF	0.457	0.901	0.449	
TSTLSTAF	0.293	0.008	0.308	

Table 5.7: Summary of univariate analyses results for Operating Efficiency Indicators

The results summarized in table 5.7 suggest that traditionally managed hospitals were on average performing significantly ($p < .01$) higher on patient services as measured by outpatient visits (OP_DISC), x-ray procedures (X_DISC), number of surgeries per discharge (SURGDISC); while contract managed hospitals tend to provide on average significantly ($p < 0.1$) more surgical operation specialties.

However, although traditionally managed hospitals were on average lower in medical and nursing staff levels, and in medical staff qualifications, they were performing more surgical operations per discharge. This trend raises some concern about the services provided to patients, since surgical procedures are typically significant in determining length of stay (Deprez et al 1987, Carrigan and Martin

1992), whilst this study found that traditional hospitals had shorter lengths of stay. When surgery per discharge was disaggregated into minor and major operations, it was found that the two groups of hospitals did not differ significantly on the major surgeries per discharge even after being adjusted for case severity. However they did differ significantly on the minor surgeries per discharge ($p=0.000$), with traditionally managed hospitals on average having over doubled the rate of CM hospitals (.2 compared to .09 for contract managed hospitals).

Apparently there are differences between the two groups of hospitals in terms of staff availability and productivity. Traditionally managed hospitals have on average significantly lower staffing ratios ($p< .05$), but their staff productivity levels are on average higher than those of contract managed hospitals. This may indicate a movement away from the efficient allocation of personnel resources in contract managed hospitals. The inefficient allocation may be a result of the contract specifications being set assuming a full operational level, whereas the occupancy rates and other bed utilization ratios (BTOR and BTOI) are typically low.

If hospitals were matching their staffing levels with patient care activity, one would expect to find a strong relationship between admissions and number of staff. However, although the Pearson correlation coefficient is .670 and statistically significant at the level .01, figure 5.1 shows that excluding hospital 52 (contract managed) which has a very high number of admissions for the available staff, contract managed hospitals tend to have fewer admissions per member of staff.

When admissions are regressed against number of medical, nursing and non-medical staff across all 75 hospitals, all three staff groups were significant with regression coefficients of – 31.1, + 37.9 and + 0.898 respectively.

Whilst this result should not be taken literarily, the negative coefficient for medical staff suggests that they do not contribute directly to hospital throughput. A partial explanation of this finding is that some specialties (i.e. cardiac or neuro surgeries) are provided in some hospitals even if the need is limited to small number of patients.

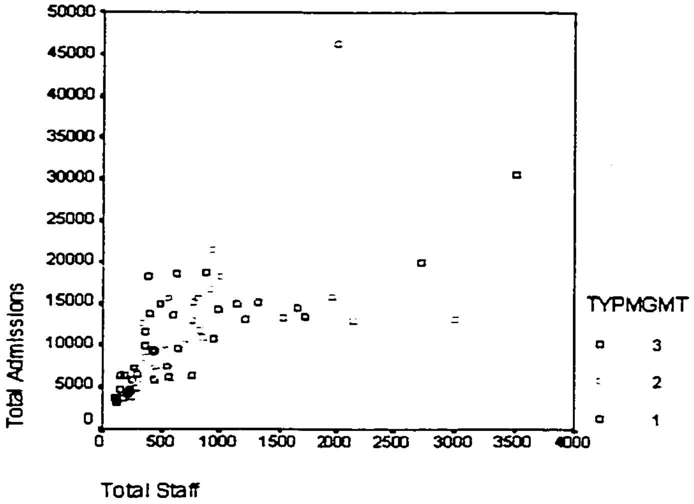

Figure 5.1: Scatterplot of admissions and total staff

Differences in staffing patterns between the types of hospital management are presented in table 5.8. They show that whilst the medical staff proportions are virtually the same, the nursing staff and nonmedical staff proportions differed significantly by type of management, even after differences in size and regional location were taken into account, (p= .003 and p= .016 respectively). Contract managed hospitals had on average lower nursing staff proportions and higher non-medical staff proportions.

		Type of Mgmt		P value
	Full service (Type 1)	Comprehensive (Type 2)	Traditional (Type 3)	
Medical staff %	.13	.12	.14	.157
Nursing staff %	.30	.28	.35	.003
Non-medical staff %	.57	.61	.55	.025

Table 5.8: Staffing Pattern

To shed more light on the non-medical staff differences, they were disaggregated into technical staff (paramedical specialists and technicians) and non-technical staff (administrative, non-medical specialists and technicians, and housekeeping). On average the non-technical group accounted for about 70% of the non-medical staff in the contract managed hospitals compared with 58 % in the traditionally managed hospitals.

Although it was hoped that contract management related patterns of bed usage might emerge at this stage, none of the bed throughput measures (ALOS, OCC_R, BTOR, BTOI) were significantly related to type of management. This issue will be returned to later in this chapter.

5.2.3 Quality of Care Ratios

Table 5.9 summarises the results of the ANOVA investigation into the relationships between the 13 quality of care indicators and type of management, when hospital size and regional location are accounted for. Of the 13 indicators 7 differed significantly ($p<.05$) by type of management, 4 differed significantly by hospital size, and 2 differed significantly by regional location. In addition some significant interactions were found and listed in the right hand column of table 5.9.

No significant difference was found between contract and traditionally managed hospitals in death rates even after adjusting for case severity of illness differences (ADJMRIDI). On the other hand, contract and traditionally managed hospitals differed significantly ($p< .05$) in the perinatal mortality rate (PNMTNB). However, Bonferroni multiple comparisons indicated the difference was between traditionally managed and comprehensive contract managed hospitals, at 0.072, where the latter had a higher mean.

	Type of Mgmt	Bed category	Region	Interactions
Dependent Variables	**P-value**	**P-value**	**P-value**	
ADJMRIDI	0.92	0.178	0.158	
PNMTNB	0.038	0.983	0.095	
CONSLTMD	.000	.000	.054	Type of Mgmt by size (p=0 .001) Type of Mgmt by region (p=0 .01)
SGCT_SGN	.000	.031	.307	All two way interactions (p=0.01)
RN_TN	.002	.172	.165	
CSOBG	.000	.031	.003	Bed category by region (p= 0.004)
CA_NBA	.000	.261	.09	
PMA_NBA	.073	.292	.623	
CDP_NBA	.007	.000	.000	Type of Mgmt by Bed category (p=0 .001) Type of Mgmt by region (p=0 .001)
PMD_NBA	.304	.771	.740	
PMDDLNBA	.302	.772	.831	
DAD_NBA	.172	.959	.407	

Table 5.9: Summary of GLM analyses results for Quality Indicators

There is some evidence that Contract management can raise a hospital's quality, as indicated by the structural quality indicators [ratio of consultant physicians to total physicians (CONSLTMD) and consultant surgeons to total surgeons (SGCT_SGN)]. After accounting for hospital size and regional location, the differences were significant ($p < .01$). The two indicators were on average higher for contract managed hospitals. Differences in the same indicators were also significant between the hospital size groups ($p < .01$ and $p < .05$ respectively), where large hospitals on average had the higher proportions of consultant staff.

One possible explanation of the higher proportions of consultant surgeons might be the number of surgical specialties. This is supported to some extent by figure 5.2 which shows that contract managed hospitals tend to provide more specialties, and have a greater proportions of consultant surgeons. The Pearson correlation coefficient between consultants to surgeons' ratio and surgical specialties was high (.50) and significant at the level .01.

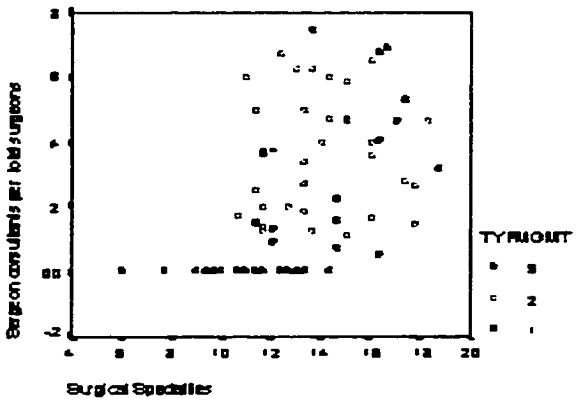

Figure 5.2

Contract managed and traditionally managed hospitals differ significantly ($p < .01$) on registered nurses as a proportion of total nurses (RN_TN), with the higher ratio at the traditionally managed hospitals. As indicated earlier contract managed hospitals follow the contract specifications which have more structured nursing services, whereas traditionally managed hospitals follow the MOH policy of recruiting registered nurses for all nursing positions. However previous research (Shukla and Turner 1984) suggest that a more structured nursing service is an organizational attribute that is positively related to quality of care

The percentage of babies delivered by caesarean section (CS_RATE), a process indicator of quality, differed significantly between contract managed hospitals and traditionally managed hospitals ($p= 0.000$), even after accounting for hospital size and regional location. Contract managed hospitals had the higher average percentage. Contract managed hospitals also tended to do more caesarean- section operations as a percentage of OB/GYN operations. As can be seen from figures 5.3 and 5.4, the caesarean-section rate is also related to the number of OB/GYN consultants, which are more present in contract managed hospitals; perhaps indicating that OB/GYN consultants tend to prefer the surgical mode of delivery.

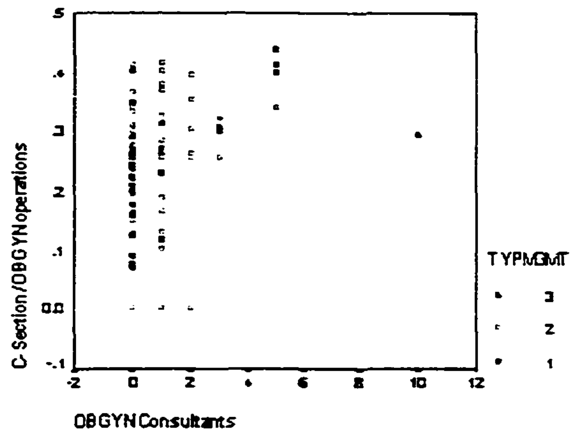

Figure 5.3

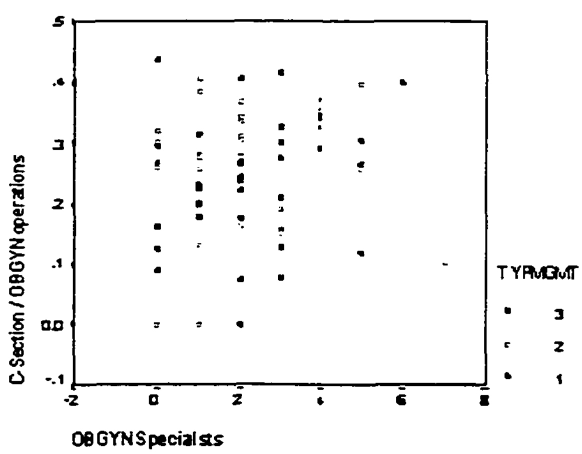

Figure 5.4

Of the six other maternity indicators examined, three differed significantly ($p < .1$) by type of management. Caesarean born alive and Caesarean dead during procedure rates were significantly higher ($p < .01$) in contract managed hospitals than traditionally managed hospitals. However these differences may in part be due to having more caesarean-section deliveries in contract managed hospitals than in traditionally managed hospitals. The premature born alive rate differed significantly ($p < .1$) between the two types of management, with the rate higher in contract managed hospitals.

5.2.4 Organizational Structure Ratios (Quantitative measures)

Administrative staff in contract managed hospitals had a significantly higher level of education than did those in traditionally managed hospitals ($p =< .001$). Nearly 35 % of the administrative staff in the full service contract managed hospitals held graduate or postgraduate degrees compared with 20% and 11% in comprehensive contract managed and traditionally managed hospitals respectively. In terms of just postgraduate qualifications, contract managed hospitals had 2.1% of their administrative staff with postgraduate degrees compared to 1.7% and 1% for the comprehensive contract and traditionally managed hospitals. These findings support the theoretical notion that contract management provides the hospital with an infusion of managerial resources.

5.2.5 Organizational Structure (Qualitative measures)

As indicated earlier, qualitative data about the management process in the hospitals were obtained through a questionnaire survey administered to the hospitals' directors. The goal of the questionnaire was to ascertain whether or not the organizational elements are implemented in the hospitals and to what extent.

Of the 75 questionnaires sent to hospitals, 74 were completed and returned. The non-respondent hospital was a large one (500 beds), managed by comprehensive contract and located in region 2.

5.2.5.1 Survey Contents

The questionnaire included 19 questions, see Appendix A, of which 17 questions required responses using a Likert type scale (Strongly Agree, Agree, Not Sure, Disagree and Strongly Disagree) .The other two were open-ended questions used to check the validity of the questionnaire. The first five questions relate to organizational charts in terms of the availability and implementation of the chart (question 1), clear definition of lines of authorities (question 2), clear definition of responsibilities (question 3), organized management and administrative functions or departmentalization (question 4), and written job descriptions (question 5).

Questions 6 to 8 relate to the availability of written policies and procedures, and their review.

Questions 9 and 10 are about the availability and execution of utilization review programs.

Questions 11 and 12 refer to quality management activities.

Questions 13, 14 and 15 relate to communication mechanisms.

Questions 16 through 19 concern hospital information systems.

The questionnaire was checked for reliability and validity. Details of these checks can be found in Appendix A.

5.2.5.2 Survey Results

The means, standard deviations, minimum and maximum scores for the survey questions are shown in table 5.10. Contract managed hospitals are outperforming traditionally managed hospitals in the organizational structure in terms of the organizational charts implemented (ORGCH1), the clearance of lines of authority (ORGCH2) and responsibilities (ORGCH3), organization of management and administrative functions (ORGCH4), availability of written policies and procedures (POLCP1 and POLCP2), availability of utilization review programs (UTLZRV1 and UTLZRV2), quality management activities (QM1 and QM2), communication mechanisms (COM1 and COM3) and hospital information systems (HIS1, HIS2,HIS3 and HIS4).

		Type of Management											
		1(N=7)				2 (N=33)				3 (N=34)			
Q. Number	**Variable name**	**Mean**	**Std. Deviation**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Min**	**Max**	**Mean**	**Std. Deviation**	**Min**	**Max**
1	**ORGCH1**	5	0	5	5	4.545	0.506	4	5	4.176	0.834	2	5
2	**ORGCH2**	4.571	0.535	4	5	4.030	0.810	2	5	3.794	0.914	1	5
3	**ORGCH3**	3.857	0.900	2	5	3.515	1.064	2	5	3.529	0.992	1	5
4	**ORGCH4**	4.429	0.535	4	5	4.061	0.429	3	5	3.794	0.914	1	5
5	**JDISC**	4.429	0.535	4	5	3.576	0.936	2	5	3.412	1.076	1	5
6	**POLCP1**	4.571	0.535	4	5	3.697	0.918	2	5	3.206	1.175	1	5
7	**POLCP2**	4.429	0.787	3	5	3.727	0.876	2	5	3.500	1.080	1	5
9	**UTLZRV1**	3.857	0.900	2	5	3.091	1.042	1	5	2.882	1.175	1	5
10	**UTLZRV2**	3.857	0.900	2	5	3.303	1.015	1	5	3.000	1.015	1	5
11	**QM1**	4.571	0.535	4	5	4.273	0.839	2	5	4.147	0.857	2	5
12	**QM2**	3.857	1.069	2	5	3.758	0.902	2	5	3.059	1.254	1	5
13	**COM1**	4.571	0.535	4	5	4.364	0.489	4	5	4.294	0.524	3	5
15	**COM3**	4.571	0.535	4	5	4.364	0.489	4	5	4.118	1.038	1	5
15	**HIS1**	4.000	1.414	2	5	2.485	1.439	1	5	1.882	1.008	1	5
17	**HIS2**	4.429	0.535	4	5	2.818	1.380	1	5	2.000	1.044	1	5
18	**HIS3**	4.714	0.488	4	5	3.091	1.528	1	5	2.412	1.459	1	5
19	**HIS4**	4.571	0.535	4	5	3.030	1.468	1	5	2.471	1.398	1	5

Table 5.10 Survey summary statistics by type of management (mean score, standard deviation minimum and maximum scores

Table 5.11 shows the mean scores by hospital size grouping. Large hospitals scored higher in all questions reflecting a relatively more structured organization.

	Hospital Size							
	Small				Large			
Variable name	Mean	Std. Deviation	Min	Max	Mean	Std. Deviation	Min	Max
ORGCH1	4.342	0.745	2	5	4.500	0.655	2	5
ORGCH2	3.868	0.811	2	5	4.083	0.906	1	5
ORGCH3	3.263	1.057	1	5	3.861	0.867	2	5
ORGCH4	3.868	0.811	1	5	4.083	0.604	2	5
JDISC	3.500	0.952	1	5	3.667	1.069	1	5
POLCP1	3.368	1.101	1	5	3.750	1.052	1	5
POLCP2	3.500	1.033	1	5	3.889	0.919	2	5
UTLZRV1	3.079	1.171	1	5	3.056	1.068	1	5
UTLZRV2	3.158	1.103	1	5	3.278	0.944	2	5
QM1	4.105	0.981	2	5	4.389	0.599	3	5
QM2	3.316	1.210	1	5	3.583	1.052	1	5
COM1	4.263	0.503	3	5	4.444	0.504	4	5
COM3	4.316	0.739	2	5	4.222	0.866	1	5
HIS1	2.211	1.359	1	5	2.500	1.404	1	5
HIS2	2.289	1.313	1	5	2.917	1.360	1	5
HIS3	2.711	1.523	1	5	3.167	1.595	1	5
HIS4	2.711	1.450	1	5	3.139	1.515	1	5

Table 5.11: Survey summary statistics by hospital size (mean score, standard deviation minimum and maximum scores

A Kruskal - Wallis test, a non-parametric equivalent of the ANOVA test, was used to test for significant differences in hospitals` organizational elements.

	Chi-Square	df	Asymp.Sig
ORGCH1	10.689	2	.005
ORGCH2	6.425	2	.040
ORGCH3	.762	2	.683
ORGCH4	4.989	2	.083
JDISC	6.978	2	.031
POLCP1	10.575	2	.005
POLCP2	5.338	2	.069
UTLZRV1	4.586	2	.101
UTLZRV2	4.742	2	.093
QM1	1.612	2	.447
QM2	6.563	2	.038
COM1	1.687	2	.430
COM3	1.220	2	.543
HIS1	11.592	2	.003
HIS2	17.474	2	.000
HIS3	13.172	2	.001
HIS4	11.435	2	.003

Table 5.12a: Test Statistics/ Kruskal Wallis Test
Grouping Variable: Type of management

A. Contract Management and Organizational Structure

For 6 of the 17 questions, contract managed hospitals had a significantly ($p < .01$) higher ranks compared with traditionally managed hospitals, see table 5.12a. These included the availability of organizational chart, availability of written policies and procedures and hospital information system. Contract managed hospitals also had significantly ($p < .05$) higher ranks for the clarity of lines of authority, availability of job descriptions and the availability of quality assessment and improvement plan. However there were no significant differences on the ranks of the communication and the utilization review answers. The mean ranks for each type of management for each question are presented in table 5.12b.

	Type of Management	N	Mean Rank		Type of Management	N	Mean Rank
ORGCH1	1	7	56	QM1	1	7	44.857
	2	33	39.864		2	33	38.455
	3	34	31.397		3	34	35.059
ORGCH2	1	7	52.500	QM2	1	7	44.857
	2	33	38.652		2	33	42.697
	3	34	33.294		3	34	30.941
ORGCH3	1	7	43.714	COM1	1	7	45.357
	2	33	37		2	33	37.773
	3	34	36.706		3	34	35.618
ORGCH4	1	7	49.929	COM3	1	7	44.714
	2	33	38.182		2	33	37.545
	3	34	34.279		3	34	35.971
JDISC	1	7	55.429	HIS1	1	7	59.714
	2	33	37.015		2	33	39.030
	3	34	34.279		3	34	31.441
POLCP1	1	7	57.929	HIS2	1	7	63.286
	2	33	39.500		2	33	40.652
	3	34	31.353		3	34	29.132
POLCP2	1	7	53.357	HIS3	1	7	61
	2	33	37.621		2	33	39.742
	3	34	34.118		3	34	30.485
UTLZRV1	1	7	52.286	HIS4	1	7	60.214
	2	33	37.894		2	33	38.985
	3	34	34.074		3	34	31.382
UTLZRV2	1	7	50.500				
	2	33	39.197				
	3	34	33.176				

Table 5.12b: Summary of Ranks by type of management

Multiple comparisons, see table 5.13 a, b and c, after Bonferroni correction at a cut off point of 0.017, show that differences were significant when full service contract managed hospitals compared with both comprehensive contract and traditionally managed hospitals. However, as expected, no significant differences were found between comprehensive contract managed and traditionally managed hospitals. Although comprehensive contracts provide hospitals with some specialized administrative staff, both groups have much in common in terms of organization and in particular administration. In both cases they are dominated by MOH staff.

	Chi-Square	df	Asymp.Sig
ORGCH1	4.964	1	.026
ORGCH2	3.240	1	.072
ORGCH3	.576	1	.448
ORGCH4	3.734	1	.053
JDISC	5.689	1	.017
POLCP1	6.078	1	.014
POLCP2	3.918	1	.048
UTLZRV1	3.276	1	.070
UTLZRV2	2.008	1	.156
QM1	.590	1	.442
QM2	.114	1	.735
COM1	1.013	1	.314
COM3	1.013	1	.314
HIS1	5.960	1	.015
HIS2	7.813	1	.005
HIS3	6.797	1	.009
HIS4	6.535	1	.011

Table 5.13a: Test Statistics / Kruskal Wallis Test
Grouping Variable: type of management (type 1 and 2)

	Chi-Square	df	Asymp.Sig
ORGCH1	8.885	1	.003
ORGCH2	5.859	1	.015
ORGCH3	.827	1	.363
ORGCH4	3.674	1	.055
JDISC	6.337	1	.012
POLCP1	8.272	1	.004
POLCP2	4.737	1	.030
UTLZRV1	4.035	1	.045
UTLZRV2	4.085	1	.043
QM1	1.525	1	.217
QM2	2.361	1	.124
COM1	1.592	1	.207
COM3	1.015	1	.314
HIS1	11.099	1	.001
HIS2	15.043	1	.000
HIS3	11.345	1	.001
HIS4	10.313	1	.001

Table 5.13b: Test Statistics / Kruskal Wallis Test
Grouping Variable: type of management (type 1 and 3)

	Chi-Square	df	Asymp.Sig
ORGCH1	3.436	1	.064
ORGCH2	1.454	1	.228
ORGCH3	.002	1	.968
ORGCH4	.998	1	.318
JDISC	.360	1	.549
POLCP1	2.983	1	.084
POLCP2	.565	1	.452
UTLZRV1	.639	1	.424
UTLZRV2	1.525	1	.217
QM1	.496	1	.481
QM2	5.664	1	.017
COM1	.246	1	.620
COM3	.130	1	.718
HIS1	2.440	1	.118
HIS2	5.637	1	.018
HIS3	3.529	1	.060
HIS4	2.351	1	.125

Table 5.13c: Test Statistics / Kruskal Wallis Test
Grouping Variable: type of management (type 2 and 3)

The results of ORGCH2 and ORGCH3 questions, (which ask about lines of authority and responsibility), indicate that the full service contract managed hospitals tend to have relatively more structured organizations with higher mean scores on both questions. This is consistent with full service contract specifications which tend to detail the functional and operational activities of the contractor. It discusses in more details the management structure of the hospital. Under the general conditions of the contract, the specifications state8, " *The contractor, within ten days of the contract starting date, must submit an organizational chart that includes:*

- *Definition and differentiation of functions, authorities, responsibilities and accountabilities.*
- *Clarification of responsibilities between the contractor's inside hospital and outside hospital activities.*
- *Titles and responsibilities for all contractor staff.*

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8 MOH Full Service Contract Specifications

The contractor is also required to appoint a project manager that is outside the hospital staff, who should be responsible for representing the contractor during the course of contract implementation. Yet, the contractor has to appoint an executive director and deputy executive director. On the MOH side, a general supervisor is normally appointed as a representative of the MOH in the hospital with the responsibility of overseeing the implementation of the contract according to the contract specifications. The project manager and the executive director both report directly to the general supervisor. The contract specifications also state, " *The contractor has to accept and adhere to the instructions conveyed by the general supervisor within the limits of his delegated authority as if it has been conveyed by the MOH".*

The contract scope of work stipulates that the contractor undertakes the responsibility of preparing and implementing a manual of written policies and procedures for all sections in the hospital. Other manuals required from the contractor are job descriptions, training and continuous education, safety, disaster plan and infection control plan. It also stipulates establishing a quality management programs.

B. Hospital Size and Organizational Structure

Mann-Whitney test, an equivalent of t-test, is also used to examine the differences in scores by hospital size. The results revealed that small and large hospitals significantly differed on ORGCH3 ranks ($p = .012$) with large hospitals having higher mean rank. Also the two groups differed significantly on HIS2 ranks ($p = .047$) with large hospitals having higher ranks. HIS2 refers to the use of computerized information management systems for non- clinical information.

Figure 5.5 shows, as expected, that small hospitals tend to have small numbers of total staff, in fact the average bed staffing ratio is virtually the same for small and large hospitals.

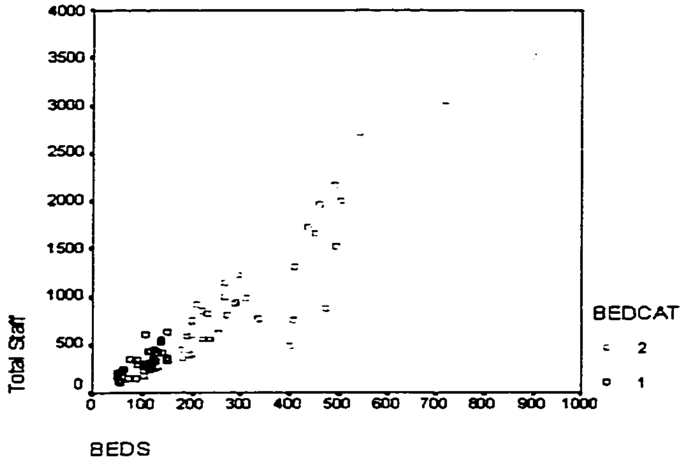

Figure 5.5

C. Regional Location and organizational Structure

Results from Kruskal-Wallis tests (Table 5.14) revealed no significant differences between the five regional locations for any of the survey questions at the $p < .05$ level; and just three at the $p < .1$ level, i.e. POLCP1, HIS2 and HIS4.

	Chi-Square	df	Asymp.Sig
ORGCH1	1.188	4	.880
ORGCH2	4.040	4	.401
ORGCH3	4.291	4	.368
ORGCH4	5.438	4	.245
JDISC	3.913	4	.418
POLCP1	8.007	4	.091
POLCP2	1.304	4	.861
UTLZRV1	4.024	4	.403
UTLZRV2	4.680	4	.322
QM1	5.672	4	.225
QM2	4.269	4	.371
COM1	2.656	4	.617
COM3	.743	4	.946
HIS1	5.809	4	.214
HIS2	8.111	4	.088
HIS3	6.322	4	.176
HIS4	8.246	4	.083

Table 5.14: Test Statistics / Kruskal Wallis Test
Grouping Variable: Regional location

5.3 Factor Analysis

As mentioned earlier, ratio analysis involves the use of individual ratios to explore relationships; and the univariate analyses so far have mainly tried to explain variations in individual ratios. However many of these ratios will be correlated with each other, and there may well be underlying factors which can in some way account for the correlations and variations in these ratios. Factor analysis is a technique designed to find such factors, specifically looking for factors which are linear combinations of the original variables.

5.3.1 Principal Component Analysis

Principal Component Analysis, one form of factor analysis, is a variable reduction procedure (SPSS Manual 1997; Hatcher and Stepanski 1994). It shows in quantitative terms the pattern of linkages among the variables (Adcock 1964). It is appropriate when there are a number of variables measuring the same construct and some redundancy is believed to be in those variables. This redundancy can be shown by the correlations between the variables. Therefore a reduction of the variables to smaller sets can be obtained that explain the correlations within the variables and account for the large portion of variance in the original variables.

In principal component analysis, the first component extracted accounts for the largest amount of total variation in the data; the second one accounts for the next largest amount of the total variation in a dimension independent of the first. Successive components explain smaller portions of the total variation and are independent of one another. However to determine the number of meaningful components, one of the most commonly used criteria is the Eigen value- one criterion, also known as Kaiser criterion (SPSS Manual 1997; Hatcher and Stepanski 1994). With this criterion, any component with eigenvalue greater than 1 is retained and used in the analysis. Varimax Rotation is a method used in principal component analysis to review the correlations between the original variables and the components. It is based on orthogonal rotations, and is aimed to make the solution easier to interpret.

To interpret the meaning of the retained components, the variables which have high correlations with the components are looked at. The correlations are referred to as loadings, and the highly loaded variables are used to try to give conceptual meaning to the components. As there is no set cutoff point for loadings, loadings greater than 0.5 are used in this research. Hair et al (1984), use a conservative cutoff of 0.6. However, ORGCH1 was eliminated because it had high loadings in a component of its own.

5.3.1.1 Operating Efficiency Components

Four components emerged from the operating efficiency variables as presented in table 5.15. They accounted for 27.1%, 18.7%, 18.4% and 11.6% of the variance respectively, and a total of 75.8%.

	Component			
Variable	**1**	**2**	**3**	**4**
ALOS	.883	-.131	.166	-5.301E-02
OCC_R	.160	.912	4.920E-02	-.122
BTOR	-.577	.748	-.107	-1.108E-02
BTOI	.296	-.907	6.045E-02	.104
OP_DIS	1.480E-02	-.328	2.213E-02	.701
SURG_TYP	.635	.257	-3.519E-02	-.336
LAB_DISC	.740	-.147	.371	.106
X_PATIET	.727	-9.979E-02	-.154	-.382
X_DISC	.787	-.259	.219	.124
DISCTMED	-.457	.524	-.583	9.409E-02
TMEDBED	.360	2.748E-02	.721	-9.215E-02
SURG_SGN	-6.531E-02	.454	-.328	.648
NURS_BED	.348	.336	.705	9.313E-02
DISC_NR	-.627	.285	-.542	-6.674E-02
NMSTFBED	-.118	-1.427E-02	.824	-.169
DISNMSTF	-9.408E-02	.429	-.749	.171
MJRSGDIS	.816	-5.153E-03	.161	6.235E-02
MNRSGDIS	-3.919E-02	-2.977E-02	-.163	.881

Table 5.15: Operating Efficiency Components
Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization. a Rotation converged in 8 iterations.

High scores on the first component would occur in hospitals with a high length of stay (ALOS)), high number of surgical specialties (SURG_TYP), high lab-tests per discharge (LAB_DISC), high x-ray per patient (X_PATIET), high x-ray episodes perdischarge (X_DISC), low discharge per nurse (DISC_NR) and high major surgeries per discharge (MJRSGDIS). A high score on the first component therefore indicates high complexity of cases.

A high score on the second component is most strongly influenced by high occupancy rate (OCC_R), high bed turn over rate (BTOR) and a short bed turn over interval (BTOI). Hence a high score on the second component indicates a high bed throughput.

The third component is most strongly influenced by high staffing levels (TMEDBED; NURS_BED and NMSTFBED) and low staff productivity (DISCTMED; DISC_NR and DISNMSTF) with negative signs. Hence a high score on component three means high staff availability, but low staff productivity.

The last component is most strongly influenced by high outpatient visits per discharge (OP_DISC), high minor surgeries per discharge (MNRSGDIS) and a high number of surgeries per surgeon (SURG_SGN). The fourth component therefore reflects outpatient activities, recognizing that minor surgeries may often take place in an outpatient basis. A higher score means higher proportion of outpatient work.

When ANOVA was then used to investigate whether the components were explained by type of management, only components three and four differed significantly by type of management (p= 0. 004 and p= 0. 000 respectively), after allowing for size and regional location. The results suggest that contract managed hospitals have a higher staffing levels and less productivity than traditionally managed hospitals, while traditionally managed hospitals have more outpatient activities.

Component three also differed significantly by regional location ($p < 0.05$), with a significant interaction with hospital size ($p < 0.05$). Region 5 has the lowest staffing level followed by region 4, while region 3 has the highest staffing level.

5.3.1.2 Quality of Care Components

On the quality of care side, five components emerged as presented in table 5.16. They accounted for 26%, 17.7 %, 16.3 %, 13.9 % and 10.6 % of the variance respectively, and a total of 84.5%.

Variables	Components 1	2	3	4	5
CSOBG	.883	9.527E-02	7.964E-02	.143	-3.579E-02
CS_RATE	.934	.104	.188	1.789E-02	-6.196E-02
CA_NBA	.936	.150	.193	6.711E-02	-1.355E-02
PMA_NBA	.353	.644	.139	.220	4.231E-02
CDP_NBA	-1.734E-03	.911	.198	-1.809E-02	6.121E-02
PMD_NBA	5.707E-02	2.738E-02	5.050E-03	.885	.103
PMDDL_NBA	8.955E-02	.885	-5.368E-03	-3.447E-02	2.392E-02
DAD_NBA	.127	3.749E-02	3.566E-02	.855	-.106
ADJMRIDI	-.264	8.984E-02	.143	-.118	.877
PNMTNB	.555	3.102E-02	-7.057E-02	.244	.684
CONSLTMD	.190	.184	.938	2.252E-02	8.178E-02
SGCT_SGN	.162	8.236E-02	.952	2.457E-02	2.650E-02

Table 5.16: Quality of care components
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 6 iterations.

The first component (caesarean section) is most strongly influenced by caesarean section indicators (CSOBG; CS_RATE and CA_NBA) with a high score meaning a high level of caesarean sections. This can be interpreted as indicating low quality.

A high score on the second component (maternity critical cases) will occur if there are high rates of caesarean born babies dead during procedures (CDP_NBA), premature babies born dead during procedure (PMDDL_NBA) and premature born alive rates (PMA_NBA). A high score on component two means more babies dead during labor, and therefore indicates low quality.

The third component (medical staff qualifications) is most strongly influenced by the percentage of consultants among the medical staff (CONSLTMD) and the percentage of consultant surgeons among the surgeons (SGCT_SGN). As a structure indicator of quality, a high score on component three suggest better quality.

A high score on the fourth component (babies with critical conditions) is most strongly influenced by rates of premature babies born dead (PMD_NBA) and dead after delivery (DAD_NBA), reflecting babies with critical conditions. A high score implies higher mortality, and hence indicates a low quality.

The fifth component (mortality) is most strongly represented by overall mortality rates i.e. case severity adjusted death rate (ADJMRIDI) and perinatal mortality rate (PNMTNB). Both variables are widely used indicators of quality, with a high score on component five indicating poor quality.

For the quality of care components, ANOVA revealed that only component one and three differed significantly by type of management (p= 0. 000) after allowing for size and regional location. The results suggest that contract managed hospitals have significantly higher medical staff qualifications, and tend to use caesarean sections more often. The results may be linked to, either because contract managed hospitals have more qualified medical staff and hence attract complex maternity cases; or because those more qualified staff choose to perform more caesarean sections.

5.3.1.3 Organizational Structure Components

Organizational structure survey questions were grouped into five principal components, as presented in table 5.17. They accounted for 24.5 %, 17.95 %, 11.6 %, 10.3 % and 6.6% of the variance respectively, and a total of 71 %.

Variables	Components 1	2	3	4	5
ORGCH1	0.33260	0.17464	0.47910	0.47643	-0.15427
ORGCH2	-0.05198	-0.14389	0.61657	0.36891	0.39439
ORGCH3	0.04084	0.10634	0.04157	0.00017	0.89053
ORGCH4	0.20842	0.09954	0.86679	-0.00001	0.04875
JDISC	0.69133	0.24042	0.34960	0.08002	-0.13121
POLCP1	0.59981	0.18654	0.48017	0.15085	-0.19762
POLCP2	0.60753	0.19737	0.44712	0.10299	-0.11253
UTLZRV1	0.88424	0.13357	0.05064	0.12862	0.08873
UTLZRV2	0.84835	0.15404	-0.00467	0.12350	0.12271
QM1	0.64460	0.24735	-0.00519	0.32435	0.02566
QM2	0.80852	0.15166	0.14528	0.03019	0.01184
COM1	0.26276	0.11709	0.04768	0.71816	0.16393
COM3	0.07136	0.12992	0.11844	0.80332	-0.08659
HIS1	0.27296	0.82902	0.05046	0.00387	-0.03161
HIS2	0.10662	0.86859	0.10395	0.08448	0.10278
HIS3	0.17312	0.83003	0.06341	0.19646	-0.07286
HIS4	0.20078	0.74844	0.0116	0.09690	0.09708

Table 5.17: Organizational Elements Survey components
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 7 iterations.

The first component (Work specification activities) is influenced by seven variables: job description (JDISC), policies and procedures (POLCP1 and POLCP2), utilization review (UTLZRV1 and UTLZRV2) and quality management (QM1 and QM2).

The second component (hospital information systems) is most strongly influenced by hospital information systems variables (HIS1, HIS2, HIS3 and HIS4).

The third component (organizational chart) is most strongly influenced by two of the organizational chart variables: clear lines of authority (ORGCH2) and organized management and administrative functions (ORGCH4).

The fourth component (communications) is most strongly influenced by communications variables (COM1 and COM3) .

The fifth component is dominated by only one variable (ORGCH3) with an eigenvalue that is barely over 1.

This principal component analysis is the same as the one used in the survey validity testing,

The ANOVA results revealed that only component 2 (hospital information system) significantly differed by type of management (p= 0. 003) after allowing for size and regional location differences. Bonferroni multiple comparisons revealed that full service contract managed hospitals had a significantly higher mean than comprehensive contract managed hospitals and traditionally managed hospitals. No statistically significant differences were found between the latter two.

5.4 Discriminant Analysis

Another way of dealing with data in a multivariate space is to find the linear combinations of variables that are useful for discriminating between groups of interest.

In section 5.2 and 5.3, performance was examined by looking at the effect of type of management and other confounding factors on the performance indicators. ANOVA and regression analyses were used to predict performance indicator when the type of management is known. In this section the process is reversed. The aim is to look if the type of management can be predicted given the set of indicators, and hence to identify the combinations of performance indicators that best characterize membership of the three types of management.

Discriminant analysis is a statistical technique which investigates differences between mutually exclusive groups with respect to several variables simultaneously (Klecka 1980). In this approach a discriminant function or functions are derived from the set of data that represent the combinations of variables that separate various groups from each other. The number of discriminant functions can be as many as one fewer than the number of groups or equal to the number of variables, which ever is smaller, however only the first one or two discriminant functions reliably discriminate among groups (Tabachnick and Fidell 1989).

Reliability of the discriminant function is measured by the size of the eigenvalue, and is related to the discriminating power of the function. The size of the eigenvalue is helpful for measuring the spread of the group centroids in the corresponding dimension of the multivariate space (SPSS 7.0 Manual). Another way to judge the reliability of the discriminant function is by examining the canonical correlation coefficient (Tabachnick and Fidell 1989). It measures the degree of relatedness between the groups and the discriminant function. The canonical correlation squared is the proportion of the variation in the discriminant function explained by the groups.

In discriminant analysis, there is no defined procedure for selecting the best set of predictors; nor an ideal test to confirm it. However one overall objective for the chosen classifying set is to minimize the total numbers of misclassifications (Krzanowski 1988; Kendall 1957). The suggested method for testing the misclassification is referred to as the " cross- validation" method. It consists of determining the classification using the data set minus one observation, and then using the consequent rule to classify the omitted observation.

5.4.1 Predictions Based on Operating Efficiency Indicators

Predicting the type of management membership using the operating efficiency indicators yielded two discriminant functions, as presented in table 5.18. The first contains 71.8 % of the discriminating power and has a canonical correlation of 0.82, whereas the second has 28.2 % of the discriminating power and has a canonical correlation of 0.67.

Wilks' Lambda (table 5.19) is the proportion of the total variance in the discriminant scores not explained by the differences among the groups. In this case Wilks' Lambda is 0.179, which is highly significant (p= .000), and indicates strong evidence that the means of all the variables across groups are not equal (group centroids)

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	2.080	71.8	71.8	.822
2	.815	28.2	100.0	.670

Table 5.18: The first two canonical discriminant functions analysis.

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	.179	103.264	46	.000
2	.551	35.773	22	.032

Table 5.19: Wilks' Lambda statistics

The classification results (table 5.20) showed that 87.8 % of the original cases were correctly classified, and that 73 % of the cross-validated cases were correctly classified. Referring to the classifications based on the full original set of hospitals; over 90 % of type 2 and type 3 were correctly classified. The six associated miss-classifications were between type 2 and 3. There were three misclassified type 1 hospitals, all predicted to be type 2.

				Predicted Group Membership		Total
		TYPMGMT	1	2	3	
Original	Count	1	4	3	0	7
		2	0	31	3	34
		3	0	3	30	33
	%	1	57.1	42.9	.0	100.0
		2	.0	91.2	8.8	100.0
		3	.0	9.1	90.9	100.0
Cross-validated	Count	1	3	4	0	7
		2	1	28	5	34
		3	1	9	23	33
	%	1	42.9	57.1	.0	100.0
		2	2.9	82.4	14.7	100.0
		3	3.0	27.3	69.7	100.0

Table 5.20: Classification Results

a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

b 87.8% of original grouped cases correctly classified.

c 73.0% of cross-validated grouped cases correctly classified.

When the coefficients of the two discriminating functions are examined, see table 5.21, function 1 is dominated by variables that distinguish traditional management (type 3) from contract management (type 1 and 2). On the other hand, function 2 attempts less successfully, to separate full service from comprehensive contracts.

Operating Efficiency	Function 1	Function 2
MNRSGDIS	.399*	.222
DISNMSTF	.361*	.028
OP_DIS	.354*	.118
NMSTFBED	-.348*	-.128
SURG_TYP	-.295*	-.036
MEDBED	-.257*	.160
BEDS	-.254*	.125
DISCTMED	.239*	-.195
SURG_SGN	.226*	.071
DISC_NR	.192*	-.182
X_PATIET	-.180*	-.056
ALOS	-.170*	-.013
LAB_DISC	-.102*	.065
X_RSTAF	.099*	-.080
NURS_MD	.098*	.092
MJRSGDIS	-.094*	-.070
TSTLSTAF	.043*	-.016
X_DISC	.015*	.000
NURS_BED	-.210	.228*
OCC_R	-.083	-.213*
BTOI	.010	.183*
BTOR	.105	-.180*
EM_DIS	-.025	.101*

Table 5.21 : Discriminant functions structure Matrix
Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions.
Variables ordered by absolute size of correlation within function.
*** Largest absolute correlation between each variable and any discriminant function.**

However, it is clear from the discriminating functions that contract managed hospitals and in particular full service contracts (type 1) are characterized by high medical staffing qualifications and high caesarean section delivery rates, which is consistent with the findings when ANOVA was used in the previous section.

5.4.2 Predictions Based on Quality of Care Indicators

Predicting type of management using the quality of care indicators yielded two discriminant functions, see table 5.22. The first contains 78.7 % of the discriminating power and has a canonical correlation 0.817, whereas the second has 21.3 % of the discriminating power and has a canonical correlation 0.593.

Wilks' Lambda is 0.215 (table 5.23), indicating that 21.5 % of the variance is not explained by group differences. It is significant (p=.000), indicating strong evidence of differences between the groups centroids.

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	2.008	78.7	78.7	.817
2	.543	21.3	100.0	.593

Table 5.22: The first two canonical discriminant functions analysis

Test of Function (s)	Wilks' Lambda	Chi-square	Df	Sig.
1 through 2	.215	101.313	26	.000
2	.648	28.619	12	.004

Table 5.23: Wilks' Lambda statistics

The classification results (table 5.24) showed that 86.7 % of the original cases were correctly classified, and that 77.3 % of the cross-validated cases were correctly classified. In this case 7 of the 10 misclassifications are between type 2 and 3.

			Predicted Group Membership			Total
		TYPMGMT	1	2	3	
Original	Count	1	5	1	1	7
		2	1	27	6	34
		3	0	1	33	34
	%	1	71.4	14.3	14.3	100.0
		2	2.9	79.4	17.6	100.0
		3	.0	2.9	97.1	100.0
Cross-validated	Count	1	3	3	1	7
		2	2	24	8	34
		3	1	2	31	34
	%	1	42.9	42.9	14.3	100.0
		2	2.9	70.6	23.5	100.0
		3	3.0	5.9	91.2	100.0

Table 5.24: Classification Results
a Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
b 86.7% of original grouped cases correctly classified.
c 77.3% of cross-validated grouped cases correctly classified.

When the coefficients of the two discriminating functions are examined, see table 5.25, it appears that function 1 is comparing type of management 1 to types 2 and 3. On the other hand, function 2 is comparing type of management 3 to types 1 and 2.

Operating Efficiency	Function 1	Function 2
CONSLTMD	.780*	.12
SGCT_SGN	.713*	.346
CA_NBA	.390*	.023
CSOBG	.366*	-.075
CS_RATE	.347*	-.021
PMANBA	.172*	.077
PMDDLNBA	.140*	-.062
ADJMRIDI	.072*	-.009
RN_TN	-.229	.499*
CDP_NBA	.206	-.324*
PMD_NBA	.041	.244*
PNMTNB	.141	.239*
DAD_NBA	.146	-.163*

Table 5.25 Structure Matrix
Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions.
Variables ordered by absolute size of correlation within function.
*** Largest absolute correlation between each variable and any discriminant function.**

5.4 Summary and Conclusions

This chapter has presented results of univariate and multivariate statistical investigations into the extent to which hospital performance can be explained by type of management and other confounding variables.

Preliminary characterizations of hospitals under the three types of management were presented in table 5.3. Subsequent analyses have tested statistical significance and hence identified important interrelationships.

A. Operating Efficiency

On the operating efficiency side, the ANOVA results revealed that traditionally managed hospitals had on average lower staffing ratios, but higher staff productivity than contract managed hospitals. The less efficient allocation in contract managed hospitals may be a result of the contract specifications being set to unrealistically 'full' operational levels, whereas hospital activity, whether contract managed or not, has been rather lower, e.g. average occupancy of 68 %.

Differences in staffing patterns were examined further and showed significantly higher proportions of non-medical staff employed in contract managed hospitals, even when differences in size and regional location were taken into account.

The results also showed that traditionally managed hospitals were on average providing more services per patient, measured by outpatient visits, x-ray procedures and number of surgeries per discharge. In contrast contract managed hospitals tend to provide more surgical specialties.

B. Quality of Care

Contract management tend to raise a hospital's quality as indicated by the structural quality measures (ratio of consultants to total physicians and surgical consultants to total surgeons). However nursing qualifications were significantly higher in traditionally managed hospitals, in part due to the MOH policy of recruiting registered nurses for all nursing positions.

In terms of quality outcome measures, death rate was not significantly different by type of management even after adjusting for case severity of illness differences. However, contract and traditionally managed hospitals differed significantly in the perinatal mortality rate, with the main difference between traditionally managed and comprehensive contract managed hospitals, the latter having the higher rate.

Caesarean delivery rate as a process indicator of quality differed significantly between contract managed hospitals and traditionally managed hospitals, even after accounting for hospital size and regional location. Contract managed hospitals had a higher average caesarean delivery rate. Contract managed hospitals tended to do more caesarean- section operations as a percentage of OB/GYN operations. It was hypothesized that OB/GYN consultants tend to prefer the surgical mode of delivery.

Of the six other maternity indicators examined, caesarean born alive and Caesarean dead during procedure and premature babies rates were significantly higher in contract managed hospitals than in traditionally managed hospital.

C. Organization Structure

Contract managed hospitals were found to have administrators with significantly higher levels of education than those in traditionally managed hospitals, supporting the notion that contract management provides hospitals with an infusion of managerial resources.

The survey results revealed that contract management had a positive effect on some of the organizational elements. These included the availability of an organizational chart, availability of written policies and procedures, hospital information system, the clarity of lines of authority, availability of job descriptions and the availability of quality assessment and improvement plans. However no effect was found on communication or utilization reviews.

D. Factor Analysis

Factor analysis yielded four meaningful operating efficiency components, five quality of care components and four organizational structure components. The 'meanings' attached to these components are listed in table 5.26. These components were found to have conceptual meanings that were used in naming them.

Component Group	Component	'Meaning'	Affected by Type of Managment
Operating Efficiency	1	Case Complexity	No
	2	Bed Throughput	No
	3	Staff availability and productivity	Yes
	4	Outpatient Activity	Yes
Quality of Care	1	Caesarean Section	Yes
	2	Maternity Critical Cases	No
	3	Medical Staff Qualifications	Yes
	4	Babies with Critical Conditions	No
	5	Mortality	No
Organizational Elements	1	Work Specification Activities	No
	2	Hospital Information Systems	Yes
	3	Organizational Chart	No
	4	Communications	No

Table 5.26: Summary of Principal Components

ANOVA was used, to check whether component scores were affected by type of management. Two operational efficiency components, two quality of care components, and one organizational structure component were affected, as indicated in the final column of table 5.26.

E. Discriminant Analysis

Discriminant functions to predict type of management based on efficiency ratios and based on quality of care ratios were developed. The discriminating functions were able to correctly classify 73 % and 77.3 % of the cross validated grouped cases using the operating efficiency and quality of care variables respectively. In each case one of the functions was mainly to distinguish type 1 hospitals from type 2 whilst the other was to distinguish type 2 from type 3.

One of the main observations from this chapter is that, although traditionally managed hospitals were achieving higher staff productivity, contract managed hospitals tend to provide a greater range of surgical specialties and show more quality indications. This highlights an important debate about the possible trade-off between efficiency and quality, and whether any group is achieving one at the expense of the other. This issue will be considered further in chapter seven.

Chapter Six: Data Envelopment Analysis of Hospital Performance

6.1 Introduction

In contrast to the limitations of ratio analysis and regression in dealing with multiple inputs and multiple outputs simultaneously in technical efficiency assessments, Data Envelopment Analysis (DEA) is a non-parametric approach used in technical efficiency evaluation studies, which can simultaneously accommodate multiple inputs and multiple outputs. This feature is particularly useful for applications in the health care industry, where the mix of services (outputs) is a product of a mix of inputs and no single direct relation can be separately established between any output and any input without considering other outputs and inputs.

Another advantage of DEA is that it compares each unit to the best performance among the group rather than to average performance of the group by using the extreme measure (location of efficient units on the best production frontier). DEA also isolates less efficient units to further determine how their efficiency may be improved to the level of the more efficient units in the group.

The remainder of this chapter is organized as follows: the next section provides a general introduction to Data Envelopment Analysis including its generally recognized advantages and limitations in evaluating relative efficiency. This is followed by a literature based critique of the main methodological issues involved in the application of DEA particular in a health care setting. These include: the selection of DMUs; identification of inputs and outputs and their measures; selection of the optimization model; selection of returns to scale; weight restrictions, sensitivity analysis and robustness of efficiency scores methods. This section concludes with a summary of the DEA model specification for this research. This model is then used to obtain a range of efficiency scores for the 75 hospitals considered in this research. Finally, possible determinants of these efficiency scores are investigated, including type of management, hospital size and regional location.

6.2 Data Envelopment Analysis

Data Envelopment Analysis has been applied by several studies to measure the technical efficiency within different industries, amongst them the Health Care industry. DEA is a linear programming approach, developed by Charnes A., Cooper W.W. and Rhodes E. (CCR) in 1978 building on the work of Farrell (1957). Charnes, Cooper and Rhodes extended traditional ratio analysis to the case of multiple inputs and multiple outputs. The DEA procedure is designed for evaluating the relative efficiency of public sector units performing similar missions and for which actual measures of inputs and outputs are available. It is based upon the economic notion of Pareto optimality, where a unit is not technically efficient if some other unit or some combination of units can produce the same amount of output with less of some resources and not more of any other resources. A unit is said to be Pareto efficient if the above is not possible (Lewin and Money 1981).

In their original paper Charnes, Cooper and Rhodes (CCR) introduced the generic term " Decision Making Units" (DMUs) to describe the collection of units which have common inputs and outputs. One of the main assumptions of DEA is that a DMU is a production unit, in that it exists primarily to convert inputs (resources) to outputs (products or services). In this study, for example, a hospital is viewed as an entity that converts the inputs of medical and non-medical staff, equipment, supplies etc. into the output of patient care.

Under the DEA approach a fractional linear program is formulated to search for the optimal combination of outputs for a given level of inputs (maximization mode), or the optimal level of inputs for a given level of outputs (minimization mode). This is accomplished by forming the ratio of weighted sum of outputs to weighted sum of inputs, where the weights for both outputs and inputs are selected in a manner that calculates the Pareto efficiency of the DMU. The linear program is in the following form:

$$\text{Max Eo} = \sum_{r=1}^{s} U_r Y_{ro} \;/\; \sum_{i=1}^{m} V_i X_{io}$$

subject to

$$1 \geq \sum_{r=1}^{s} U_r Y_{ro} \;/\; \sum_{i=1}^{m} V_i X_{io} \quad ; \qquad o = 1,2,\ldots\ldots,n$$

and

$0 < Ur \qquad r = 1,\ldots\ldots\ldots\ldots,s$

$0 < Vi \qquad i = 1,\ldots\ldots\ldots\ldots,m$

Where

E_o = the relative efficiency score of DMU_o

n = the number of DMUs being assessed

Yr_o = the observed amount of output r produced by DMU_o

X_{io} = the observed amount of input i used by DMU_o

U_r , V_i = the weights calculated for output r and input i respectively

s , m = the total number of output and input measures respectively

DEA treats the observed inputs (X_i) and outputs (Y_r) in this ratio as constant and chooses optimal values of the variable weights to maximize the efficiency of the DMU relative to the performance of the other DMUs (Ganley and Cubbin 1992). Therefore the purpose of DEA is to measure relative efficiency among similar institutions (DMUs) that share the same technology (processing procedure) to gain similar achievements (outputs) by using similar resources (inputs) (Perez et al 1988).

In DEA the relative efficiency of a DMU is defined by its position relative to the frontier of best performance established by the ratio of weighted sum of outputs (virtual output) to weighted sum of inputs (virtual input). According to Charnes and Cooper (1985), a DMU on the frontier and has 100% efficiency only when:

1. None of its outputs can be increased without either increasing one or more of its inputs or decreasing some of its other outputs.
2. None of its inputs can be decreased without either decreasing some of its outputs or increasing some of its other inputs.

The original DEA model (CCR) assumes constant returns to scale and was later extended by Banker et al (1984) to incorporate variable returns to scale. The new extension was denoted by BCC model. CCR and BCC models are the two basic DEA models, and are often used in the application of DEA.

DEA enthusiasts claim that it has a number of advantages (compared to alternative approaches) for comparing the efficiency of DMUs with multiple inputs and multiple outputs, such as hospitals. On the other hand its critics highlight its limitations. These are clearly relevant for this work when attempting to interprete the results of DEA, and are therefore briefly highlighted in the next two sub-sections.

6.2.1 DEA Advantages:

DEA has many advantages and desirable features noted in the literature which can be summarized as follows:

1. It provides a single summary of the relative efficiency for a set of DMUs, such as hospitals.
2. DEA does not require prior weights on inputs and outputs.

3. Whilst DEA assumes the existence of a production function it does not require any assumptions about functional form, and hence it is not necessary to prescribe the relationship between inputs and outputs (Seiford and Thrall 1990).
4. DEA provides useful information on how the inputs and the outputs should be adjusted in order to transform inefficient DMUs into efficient DMUs (Shafere and Bradford 1995). This information can be used by decision-makers as guidance in improving DMUs efficiency.
5. Finally it provides a measure of relative performance that is independent of resource prices, which is important for applications where input prices are not available (Ruggiero 1997)

6.2.2 DEA Limitations:

As with any other analytical tool, DEA has its limitations, which can be summarized as follows:

1. DEA is capable of addressing efficiency only and doesn't evaluate the effectiveness of the inputs used and the outputs gained (Perez et al 1988).
2. The results of the DEA model are dependent on the choice of inputs and outputs. Different sets of inputs and outputs will yield different efficiency scores.
3. DEA cannot identify the specific operating procedures or managerial decisions that would improve efficiency.
4. DEA can have weak discriminating power, when the number of DMUs is not large enough compared to the total number of inputs and outputs.
5. The free weight feature inherent in the model can lead to unrealistic weight distributions. This occurs when some DMUs can be rated as efficient by

applying extremely large weight to a single output and / or a single input which may be practically unreasonable or undesirable (Xiao – Bai and Reeves 1997).

6.3 Methodological Issues

The application of DEA procedure comprises several phases.

- The first relates to defining and selecting the DMUs to be assessed.
- Second the identification of the relevant inputs and outputs.
- Third is selecting the optimization model.
- Fourth is the selection of a return to scale model.
- The final phase is dealing with issues concerning the application of the DEA models and the interpretation of the results.

Each phase in turn involves several steps and requires careful attention, as discussed in Thanassoulis et al (1987), Golany and Roll (1989), Charnes et al (1994) and Smith (1997). The issues involved in each phase, and their implications for the current research are discussed next. In addition to general DEA literature, the discussion is based on 32 hospital applications of DEA summarized in table 6.1.

6.3.1 Selection of DMUs:

The set of DMUs in a DEA efficiency study should be a homogeneous set, with activity measurements for the same period, so that the comparison is meaningful and the differences identified are sensible.

In this study the selected DMUs are the 75 general acute hospitals owned by and operated under the control of the Ministry of Health in Saudi Arabia. The selected hospitals form a reasonably homogeneous set with a common role and objectives, use the same technology (inputs, outputs and processing procedures are identical) and operate under similar environments.

However it is important to note that this does not guarantee complete homogeneity. For example the hospitals vary in size, are in five different regions in Saudi Arabia, and many have different case mixes. These factors will be considered during analysis and interpretation of the results.

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Banker, Conrad & Strauss (1986)	114 North Carolina Hospitals	- Nursing Services - Ancillary Services -Administrative Services - Capital	- Pediatric Inpatient days - Adult Inpatient days - Geriatric Inpatient days	Limited to One State
Bannick and Ozcan (1995)	284 federal (158 VA & 126 DoD) Hospitals 1989 AHA Annual Survey	- Capital Investment (Beds & Service Mix) - Labour (Physicians, Nursing & Supporting Personnel) - Supplies (Operational Expenses)	- Inpatient days - Outpatient Visits	DoD & VA hospitals
Bitran & Valor-Sabatier (1987)	160 not for profit chain hospitals(Surgery, Psychiatry and OPD services were excluded)	- Direct FTE's - Direct salary expenses - Other direct expenses	- Discharges in 15 major diagnostic categories	
Borden (1988)	52 New Jersey Hospitals	- Total FTE's - Nursing FTE's - Number of Beds -Non-Payroll Expenses	- Number of Cases in each of the highest volume DRG'S - Number of Cases in all other DRG's	Limited to One State

Table 6. 1 Summary of Studies Related to Hospital Efficiency

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Burgess and Wilson (1996)	134 VA, 319 Non Federal, Profit 254 and 1539 Non profit FY 1988	- Acute beds - Long-term beds - Registered Nurses - Practical Nurses - Other clinical labor - Non clinical labor Long term Care labour	- Acute care inpatient days - Case mix adjusted acute inpatient discharges - Long term inpatient days - Outpatient visits - Ambulatory Surgical procedures - Inpatient surgical procedures	-Type of owner ship (Private nonprofit, Private for-profit, Federal and local Govt).
Burgess and Wilson (1998)	137 VA hospitals with bed size > 100 beds and 1413 non VA hospitals Data for 1985- 1988	- Acute beds - Long-term beds - Registered Nurses - Practical Nurses - Other clinical labor - Non clinical labor - Long term Care labour	- Acute care inpatient days - Case mix adjusted acute inpatient discharges - Long term inpatient days - Outpatient visits - Ambulatory Surgical procedures - Inpatient surgical procedures	- Type of ownership (VA. Local Govt, Non -profit and for- profit)
Chang (1998)	6 Central Govt. Owned Hospitals in Taiwan 1990 – 94	- FTE Physicians - FTE Nurses - FTE Admin Personnel	- Clinic Visits - Weighted Patient days (Acute, Intensive and Chronic)	

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL Variables
Chilingerian & Sherman (1990)	15 Physicians treating 128 cases of Heart Failure	- Length of Stay - Ancillary Charges	- High Severity Cases - Low Severity Cases	Limited to Single Hospital Satisfactory Outcomes only
Conrad and Straus (1983)	114 North Carolina Hospitals 1978 Medicare Data	- Nursing Services - Ancillary Services - Administration & General Services - Capital	- Child inpatient days - Non- Medicare inpatient days (age 14 – 65) - Medicare inpatient days (age over 65)	
Desharnais, Hogan, McMahon and Fleming (1991)	245 Hospitals	- Acute Beds - Paediatric Beds - Obstetric Beds - Plus 17 other Inputs	- Adjusted Discharges in 31 Different Categories - Residents Trained - Outpatient Visits - Outpatient Surgical	
Ehreth (1994)	All hospitals receiving Medicare Payments in the FY 1987 to 1989. Cost reports HCFA	- Fixed Assets - FTE Employees	- Adjusted Medicare Discharges - Medicaid Discharges - Other Discharges - Outpatient Discharges Equivalent	

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Ferrier and Valdmanis 1996	360 Rural Hospitals operating in the West South Central USA American Hospital Association's Survey of Hospitals 1989.	- Number of Personnel - Number of Beds	- Number of Acute days - = Subacute days - = Intensive days - = Surgeries performed - = Discharges - = Outpatients	- Type of ownership (Public, Non-Profit and for-profit) - Location
Grosskopf & Valdmanis (1987)	82 California Hospitals (200 and more beds) in Urban areas with Population > 500,000	- Physicians - FTE non –physicians - Net Plant Assets - Admissions	- Acute care days - ICU days - Surgeries - Ambulatory care visits	Public & Not for profit
Grosskopf & Valdmanis (1993)	49 hospitals from NewYork &59 from California. All Non-Profit (Private & non-federal govt.)	- Physicians - Non-Physicians Labour - Net Plant Assets - Case Mix	- Acute care inpatient days - ICU inpatient days - Surgeries - Ambulatory & Emerg. Visits	Unadjusted Inpatient days Case Mix adjusted Inpatient days
Hao and Pegels (1994)	93 Acute care VA Hospitals	- FTE Physicians - FTE Nurses - Hospital Beds	- Hospital Discharges - Surgeries - Outpatient Visits	Council of teaching Hospitals Membership

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Hollingsworth & Parkin (1995)	75 UK Acute Hospitals (ISD) NHS in Scotland 1992-93	- Drugs - Capital charge - Medical Staff - Nursing Staff - Other Staff	- Acute inpatientdays medical - Acute inpatientdays Surgical - Accidents &emergency Attendances - Outpatient Attendances - OB/GYN inpatientdays - Other Speciality inpatientdays	
Huang (1992)	213 Florida Hospitals	- Acute & ICU beds - FTE's - Case mix index - Service mix index - Capital Assets	- Adjusted Patient days - Adjusted Admissions - Outpatient Visits	
Lynch and Ozcan (1994)	1535 short term non Government , General Hospitals1984 – 1986 AHA Annual Survey	- Capital Assets - Labour (Non-physician FTE's and weighted number of part time personnel) - Supplies (Operational Expenses)	- Adjusted Discharges - Outpatient Visits - Training (Weighted sum of medical, dental and other professional trainee FTE's trained)	

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Magnussen (1996)	46 Norwegian Acute care, non-teaching hospitals. 1989 - 1994	- Physicians & Nurses FTE'S - Other Personnel FTE'S - Beds	**Patient day** - Medical days - Surgical days - Simple days - Complex days **Patient** - Medical Patients - Surgical Patients **Common** - Long term care days - Outpatient visits	
Morey, Fine and Lorey (1990)	60 Hospitals - 20 public - 40 Non-public	- Number of Beds - Type of Ownership - Case mix severity - Net plant Assets - Total Annual Expenditures	- Total acute patient days - Total intensive patients days - Number of Surgeries - Number of Outpatient Visits - Number of residents per physicians	Limited to One State - Population > 500,000 - 200 or more Beds - Public and Non public
Ozcan and Bannick (1994)	124 DoD Hospitals 1988 to 1990 AHA Annual Survey	Capital Assets - Labour (Non-physician FTE's and weighted number of part time personnel) - Supplies (Operational Expenses)	- Inpatient Days - Outpatient Visits	

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Ozcan and Luke (1993)	3000 Urban Hospitals 1987 AHA Annual Survey	- Capital Assets - Labour (Non-physician FTE's and weighted number of part time personnel) - Supplies (Operational Expenses)	- Adjusted Discharges - Outpatient Visits - Training (Weighted sum of medical, dental and other professional trainee FTE's trained)	- Ownership - Medicare - Managed care - Multi-Hospital system membership - Size
Ozcan, Luke & Haksever (1993)	3000 Urban Hospitals 1987 AHA Annual Survey	- Capital Assets - Labour (Non-physician FTE's and weighted number of part time personnel) - Supplies (Operational Expenses)	- Adjusted Discharges - Outpatient Visits - Training (Weighted sum of medical, dental and other professional trainee FTE's trained	Ownership (Government, Nonprofit & For –profit)
Ozcan, McCue and Okash (1996)	85 Psychiatric Hospitals (1990 AHA annual survey)	- Capital Assets - Labour (Non-physician FTE's and weighted number of part time personnel) - Supplies (Operational Expenses)	- Adjusted Discharges - Outpatient Visits	

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Perez (1992)	158 Continental U.S. VA Medical Centres 1989 AHA Annual Survey	- Service Mix - Non- Physician FTE's - Total operating Expenses - Total Medical Staff - Bed size	- Hospital Patient days - Outpatient Visits - Training FTE's	-Geographic location - Service area size
Register & Brunnig (1987)	457 Urban Hospitals 1984 AHA Annual Survey	- Total Personnel - Staffed Beds	- Inpatient days	For-profit & Non- profit hospitals
Sexton et al (1989)	159 VA Medical Centres FY 1985	- Nursing FTE - Physician FTE - Part-time Physician FTE - Residents FTE - Health Tech FTE - Drug and Supplies - Equipment Expenses	- Medical weighted work unit (WWUs) - Psychiatric WWUs - Surgical WWUs - Nursing Home WWUs - Intermediate – care WWUs - Outpatient WWUs	

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Sherman (1984)	7 Massachusetts Teaching Hospitals	- FTE's - Supply Expenses - Bed days Available	- Patient days >65 Years - Patient days <65 Years - Nurses trained - Residents trained	- Teaching Hospitals - One State - Medical / Surgical area only
Sherman (19986)	7 Massachusetts teaching Hospitals Medical – surgical departments only 1976 Data	- FTE's - Supply Expenses - Bed days available	- Patient days (age >= 65Y) - Patient days (age <65Y) - Nurses Trained - Interns/Residents trained	
Valdmanis (1990)	41 Michigan Hospitals 1982 AHA Annual Survey	- Number of Active & Associate Physicians - FTE non –physician labour - Net plant Assets	- Acute inpatient days - ICU days - Number of Surgeries - Ambulatory ER visits	- Public & not for profit hospitals

Table 6. 1 Continued

STUDY	DATA SOURCE	INPUT MEASURES	OUTPUT MEASURES	CONTROL VARIABLES
Valdmanis (1992)	14 Michigan Hospitals	- Attendings - House Staff - Physicians(# attending + House Staff) - Nurses - FTE other Labour - FTE non- MD Labour - Number of Admissions - Beds - Net Plant assets	- Paediatric inpatient days - Adult inpatient days - Elderly inpatient days - Acute inpatient days - ICU inpatient days - # Surgeries - Emergency Visits - Other Ambulatory Visits	- Limited to One State - Population >500,000 - 200 or more Beds
White and Ozcan (1996)	239 Hospitals (177 Not for profit and 62 Church's) in California	- Capital Assets - Labour (Non-physician FTE's and weighted number of part time personnel) - Supplies (Operational Expenses)	- Adjusted Discharges - Outpatient Visits	- Type of ownership (Not for Profit and Church)

Table 6. 1 Continued

6.3.2 Identification of Inputs and Outputs

The identification of the relevant inputs and outputs has to be based on an understanding of what resources are used to provide the types of services offered. Charnes et al (1994) recommended that all factors, which may affect the performance of the DMUs being evaluated, should be included.

The variables should reflect the important characteristics of the hospitals, which fall into three primary areas of activity: patient care, education and research (Ruchlin and Leveson1974). There is no information available about education and research at the selected hospitals that could be used in the analysis. Therefore in this study, evaluation of efficiency is restricted to patient care activity data.

The DEA literature stresses the importance of selecting the right inputs and outputs, in terms of both type and number, to accurately define the basis on which the efficiency of the hospitals is to be assessed. As a guide, the product of the number of inputs and outputs determines the minimum number of efficient hospitals that the DEA technique will produce. Hence the number of inputs and outputs affects the discriminating power of DEA (Boussofiane et al 1991). For example, a large number of inputs and outputs means that the analysis will be less able to identify inefficient units, however it will provide more information about the performance of those which are found to be inefficient.

Most of the hospital studies listed in table 6.1 confined total inputs and outputs to be 10 or less. As Ozcan (1993) stated," *the employment of more variables than necessary would resemble the model over-identification problem in multistage regression modeling*".

However as no formal criteria are available for selecting the appropriate variables or for measuring their explanatory power, there are various possibilities for specifying inputs and outputs. Hence in applications it is usual to have several iterations, to determine whether changes in the input / output specification would have any significant effects on the results.

6.3.2.1 Output Measures

Change in health status is conceptually the appropriate hospital output in modeling hospital production, as improving health status is the ultimate objective of the hospital. However improvement in health status is not easily quantified, and requires isolating and specifying the direct relationship between hospital services and health status. Studies in the literature have used hospital production outputs instead, which are assumed to be related to improved health status. This notion is supported by Grosskopf and Valdmanis (1987) and Hollingsworth and Parkin(1995). Grosskopf and Valdmanis also believed that specifying a vector of outputs rather than a single measure such as admissions or adjusted bed days better reflects hospital output and allows for variation in input usage for different types of treatments or cases.

Discharges and patient days have each been used as an output measure in studies of technical efficiency. The first will measure efficiency on the basis of resources used per patient rather than per patient day, but it ignores the amount of resource utilization that can vary between diagnosis (Juras and Brooks 1993). Thomas et al (1983) argue that the number of patient days has been traditionally used as a measure of hospitals' output, but requires adjustment to reflect patient variation in terms of case complexity and severity. They further argue that increasing dissatisfaction with using patient days to measure output have led to the development of the number of treated cases as a measure of hospital's output. Hence a hospital is seen as efficient if it treats cases at a defined level of quality with the least expenditure of resources. On the other hand Ehreth (1994) argues that patient days is a way to measure hospital production. But using patient days alone, as an output measure would give hospital managers incentives to increase length of stay, which is an indicator of inefficiency. That is a drawback the number of discharges as an output measure does not have. Huang (1990) suggested that in order to control for the effects of inducing demand on patient days the number of admissions, or equally discharges and deaths, should be used as a measure of output alongside patient days.

Studies in the literature have utilized a number of methods to adjust for case mix differences. Medicare case mix, which is derived from the DRGs, is one of the most frequently used methods. Efficiency evaluation of patient care is based on resources consumed by each patient type, and not just how long the patient stays in the hospital. For example Orthopaedic patients or terminal cancer cases may have very long stays in the hospital but their resource consumption may not be as much as a shorter stay cardiac patient who is using the cardiac intensive care unit. Sherman (1981) argues that for efficiency evaluation, case mix profile should indicate the number of patient days of services that were provided within each diagnostic category. He further argues that DRGs (which are commonly used index for case mix adjustment) do not serve the purpose properly because they are not related to total resources utilized by patients. He suggests a resource need index as a better alternative. This index is based on assigning a relative need unit (RNU) to each diagnosis. This RNU is then used to weight the number of patients treated to reflect the relative resource demands for the hospital case mix.

However, whatever the merits of DRG or RNU based case mix adjustment, which are debatable, in this study case mix adjustment of this sort is not possible because diagnostic data is not collected at the MOH hospitals. However two outputs which are available in the MOH data are minor and major surgical operations.

Surgical operations (major and minor) and the number of surgical specialties offered by the hospitals are used to indicate the hospital case mix. Surgical operations are different from medical care cases and require a different input mix, including equipment, specialized surgical staff and additional medical staff. As stated by Valdmanis (1992) this differentiation is recognized in the Diagnosis Related Groups that reimburse at higher rates for surgical cases than for medical cases. Also Hao and Pegels (1994) used surgical operations as an indicator of hospital intensity.

In addition to treating inpatients, hospitals also treat outpatients. The MOH data set includes a count of outpatient and emergency episodes.

In summary, the following list of output measures are used in this thesis:

1. Inpatient care throughput measured by **Discharges** (including Deaths) and **Inpatient days**.
2. Intensity of Care indicated by number of **surgical operations** performed and number of **surgical specialties** provided by the hospital.
3. Outpatient Care throughput measured by **outpatient and emergency episodes.**

6.3.2.2 Hospital Input measures

There are three main categories of hospital inputs (Ruchlin and Levenson 1974; Ozcan and Luke 1993; Ball et al 1998):

- Capital
- Labour
- Supplies

Capital is indicated by hospital size, which is measured by the number of **beds** or **bed days** available.

Labour is measured by four inputs, **Physicians** are an important input since they direct the treatment and resource use for their patients. To account for experience and educational differences, the number of physicians has been disaggregated into surgical and non-surgical doctors. Other labour measures used are total number of **Nurses** and total number of **Supporting Personnel (NMSTF)**. Bannik and Ozcan (1995) used these differentiated hospital labour inputs to capture the relative effect of the complex mix of hospital personnel on efficiency.

Supplies should be measured by the amount of operational expenses other than labour and capital expenses. However, because no information is available on the non-labour, non-capital operational costs, or on values of medical and non-medical supplies, the supplies category is omitted in this thesis. Results will therefore need to be interpreted with this omission in mind.

6.3.3 Optimization Model

DEA efficiency models can address two types of optimization. One places emphasis on the input side (input oriented) and the other places emphasis on the output side (output oriented).

The input oriented model looks at how much the hospitals' use of inputs could have been reduced while maintaining their current levels of outputs (input minimization). On the other hand the output oriented model looks at how much output the hospitals could have achieved given their levels of inputs (output maximization).

The choice as to which one to use in an analysis is dependent on the situation being analyzed. The output maximization model is more appropriate for situations where the target outputs generated by the analysis are actually possible to achieve;

otherwise the input minimization model is more appropriate. Similarly the input minimization model requires flexibility in input use, if inputs are determined and cannot be altered then an output maximization model would be more appropriate. Both optimization models produce identical results under the CCR model, but may yield different results under the BCC model (Golany and Roll 1989).

For the purpose of this study the input minimization model has been adopted for the following reasons:

1. Hospital management has greater control over their inputs than outputs. Most outputs depend on external factors beyond the control of the hospital management.
2. Public hospitals in Saudi Arabia are subject to budget constraints imposed by the Government, and Saudi Ministry of Health decisions reflect their interest to minimize costs without reducing services.
3. Public hospitals are not profit maximizers, but are more likely to be concerned with the utilization of their resources to make the best of their limited budgets (Ferrier and Valdmanis 1996).

6.3.4 Returns to Scale

DEA analysis can be carried out using the assumption of constant returns to scale inherent in the original model (CCR), or variable returns to scale introduced by the modified model (BCC).

Constant returns to scale (CRS) means that as inputs are increased by a certain proportion output increases by the same proportion. Whereas variable returns to scale (VRS) means that as inputs increase outputs may increase by a larger proportion than inputs (increasing returns to scale), or outputs may increase by a smaller proportion (decreasing returns to scale).

In the majority of Health services studies, the original model (CCR) with its CRS has been used for the analysis of efficiency. For example Sherman (1984), Sexton et al (1989), Ozcan et al (1992), Ereth (1994), Hao and Pegels (1994), Hollingsworth and Parkin (1995) and Thanassoulis et al (1996) used CRS, although Hollingsworth and Parkin also discussed the use of the two models together.

According to Ganley and Cubbin (1992) CRS is more comprehensive as it includes both technical and scale components of efficiency, whereas they describe VRS as termed Pure Technical efficiency. The scale component of efficiency measures whether a hospital is producing at the most efficient scale, and if not how much is the deviation from the most efficient scale. It is calculated by dividing the efficiency under CRS by the pure technical efficiency. CRS and VRS efficiencies can be considered as the lower and upper bound of efficiency.

Similarly, Grosskopf and Valdmanis (1987) argued that CRS efficiency reflects a long run efficiency, while relaxing the restriction of constant return to scale (VRS) indicates a short run attainable efficiency. For a hospital to become scale efficient a great deal of change must often take place, and this can only be achieved over a long period of time if serious disruption of services is to be avoided. Moreover government regulations and social pressures to meet demand on the service may preclude hospitals from adjusting their scale of operation to the efficient scale.

Selection of either model depends on the case being studied and the interest of the analyst. Smith (1997) argues that the interest of the analysts from a social perspective is likely to be in productivity regardless of the scale of operations, in which case the constant return to scale is more appropriate. But from a managerial perspective the interest is likely to be in the extent to which the scale of operations affects productivity, so variable return to scale may be preferred.

Given the possible importance of the above perspectives, CRS and VRS models can both be used together in efficiency assessment, to reflect the efficiency of the hospitals relative to the best performance of all hospitals and the efficiency relative to hospitals of a similar size. Using both models provides more information about hospitals in terms of improving efficiency relative to their scale size and the most efficient scale size.

6.3.5 Application and Interpretation of DEA Results

Hollingsworth et al (1999), in a recent paper reviewing DEA methods and applications in health care, reported that most studies use DEA as a straightforward application, and only a small number have tested methods such as weight restrictions or have used any statistical or sensitivity analysis of the results. Where included in the literature, weight restrictions and sensitivity analyses are mostly presented from a theoretical perspective rather than as an application to real data. In addition, few studies have employed post hoc analysis to either validate their results by comparing them with other methodologies, or performed further analysis of efficiency scores using other variables. However from an applied perspective, as in this research, these issues need careful consideration.

6.3.5.1 Weights Flexibility

The original DEA model (CCR) allows for free assignment of weights. The model permits each DMU to select any weight that it wants for each input and output provided that the weights satisfy the model conditions, (i.e. no weight can be negative, [weighted output / weighted input] ratio must not exceed one (Sexton et al 1989)). This flexibility allows each DMU to select the weights that will maximize its efficiency ratio, and therefore allows each DMU to be seen in the best possible light.

However total flexibility of weight selection may result in some DMUs being assessed on only a subset of their inputs and outputs, while the rest of inputs and outputs are ignored by assigning very low or zero weights to them. As a result the relative efficiency of the DMUs may not reflect their performance on the inputs and outputs taken as a whole. For example, their efficiency could be based on achieving a high ratio for just a single (possibly minor) output and a single (possibly minor) input, which may well be unacceptable in real applications. An obvious example from the hospital industry would be the ratio of outpatient visits to support personnel. Roll and Golany (1993) stated that " *In real world applications, whether in production or service situations, where a measure of the relative efficiencies of different DMUs is sought, virtually unconstrained factor weights are usually unacceptable*". They further argue that it is inappropriate to accord widely differing weights to the same factor. By the same token Roll et al (1991) argue that allowing a DMU total flexibility to choose weights in a manner most favourable can result in what they called " covering up" of serious deficiencies associated with very low outputs and / or very high inputs.

In the context of health services there are many reasons to introduce weight restrictions, Ball et al (1998) summarize the drawbacks of having no weight restrictions as follows:

- *A DMU that has specialized in a particular area to the neglect of others currently has more chance of being classified as efficient than the good all- rounder.*

- *The lack of discrimination, given a reasonable number of inputs and outputs is unsatisfactory, as most DMUs will be 100% efficient. Eliminating factors is conceptually unsound and is a very crude form of weight limitation – a variable gets a weight of either zero or one.*
- *In many problems, not all inputs contribute to the production of every output. This raises the possibility of reaching 100% efficiency on the basis of a meaningless ratio.*

In fact, according to Ball et al (1998), weight restrictions can be used to provide some positive discriminations:

- *Allowing some inputs and outputs to be more highly weighted than others may be appropriate, where specialist knowledge or policy suggests this to be sensible.*

However, although there are many arguments for introducing weight restrictions, total flexibility of weights can also produce valuable results. In particular they allow for the identification of inefficient hospitals which are under-performing even with their own unrestricted set of weights. Those hospitals are in need of close attention and investigation over and above that required by hospitals that are efficient under their own set of weights but not efficient under weight restrictions.

Dyson and Thanassoulis (1988) argue that efficiency assessment should incorporate a general view of the relative importance of inputs and outputs, whilst on the other hand should also allow individual DMUs to differ from the general view. The former would lead to imposing a fixed set of weights, and the latter leads to total weigh flexibility. Their attempt to resolve this problem using regression is limited to cases with multiple outputs and single input only.

Part of the ongoing debate on weight restrictions raises questions about the validity of the DEA model. Allen et al (1997), Podinovski and Athanassopolous (1998) and Podinovski (1999) argue that imposing weight restrictions changes the properties of the DEA model, in particular the objective that each DMU will achieve the maximum efficiency rating feasible for its inputs and output. Hence the relative efficiency of the assessed DMUs will not be maximal.

However imposing weight restrictions in efficiency assessment as stated by Allen et al (1997) " *has followed as a natural by-product of real-life applications*". As a way to incorporate concerns over the introduction of weight restrictions, Dyson et al (1990) suggested that a compromise ought to be sought between total weight flexibility and weight restrictions by applying weight limits that do not heavily constrain the model. This implies setting bounds on the weights to ensure that each input and output contributes to the efficiency and to avoid excessive weights or over-representation. Nevertheless, the dilemma is in finding the right set of bounds.

There are a variety of other methods proposed in the literature to obtain weights or bounds. A straightforward way of determining the variables weights is using their relative importance or values explained by their market prices. However, the lack of price information at the hospitals being assessed in this study means that this method could not be applied. A second example is inequality bounds used to define an assurance region, introduced by Thompson et al in 1985 (Thompson et al 1990), where the bounds were obtained through survey data and expert opinion. Another method is "cone ratio" suggested by Charnes et al (1989) where weights are restricted to be within given closed cones. The cones are specified by defining bounds on weights that reflect the relative importance of the inputs and outputs.

Roll et al (1991), Roll and Golany (1993) and Chillingerian and Sherman (1997) suggested a variety of approaches to determine weight bounds based on the information obtained from running the unbounded model. They suggested first running the unbounded model to compile a weight matrix after eliminating outliers (zero or excessively high weights). Taking the average weight for each variable, they then suggested determining an amount of allowable variation subjectively. Dyson and Thannassoulis (1988) suggested determining weight lower bounds using regression for the cases with single input multiple output or vice versa. Wong and Beasly (1990) developed a different approach based on using proportions. The importance of the input or output for a DMU is defined by the proportion of the total virtual input or output of the DMU devoted to that input or output. The importance of the variable is restricted by a range determined by expert opinion. But Allen et al (1997) has criticized this approach as being DMU specific.

In this research following the suggestions of Dyson et al (1990), a number of sets of weight bounds have been developed based on the information obtained in the initial analysis and the unbounded model weights approach suggested in the literature. In contrast to weights being derived from a management perspective due to the difficulty of obtaining such a subjective weights from hospitals management that is dominated by physicians with differing specialties. The method used to derive the weights can be summarized as follows: first the unbounded model is used to compile the weights assigned to the variables. Then, excluding the zero weights, the CCR and BCC minimum weights for each variable are taken as the first two sets of weight lower bounds. Third, excluding the excessively low or high (zero and 100) weights, CCR and BCC mean weights for each variable is calculated. Finally the minimum and mean weights are used to derive the other sets of weight lower bounds by allowing for an amount of variation (i.e. minimums plus 5%, 10%, 15% or 20% and means times 1/4, 1/5 or 1/6).

The sets allow for the assessment of hospital efficiency on the basis of constant return to scale weights and hospitals' scale sizes weights, and examine their impact on efficiency.

6.3.5.2 Sensitivity Analysis and Robustness of Efficiency Scores

DEA is a non- parametric method, therefore it is less sensitive to mis-specification of the production function, however it is a non-stochastic method and consequently the results are sensitive to measurement error and to variable selection.

Considered one of the main methodological weaknesses of DEA is the lack of robustness characterized by its sensitivity to extreme outliers, which can define the "best" performance. In terms of data and choice of input and output variables, Sexton et al (1986) argued that measurement error in inputs and outputs can have serious effects on the DEA results, especially if the error occurs in an efficient unit. They also argued that variable specification affects the result, where a unit can be made efficient through the increased number of inputs and outputs in the model. As they stated, in standard stochastic models variables may be assessed using F and R squared statistics which have no counterparts in DEA.

Several attempts are presented in the literature to overcome this problem. Charnes et al (1985) suggested performing various sensitivity analyses to identify the influence of individual observations on the frontier. Sexton et al (1986) recommended the use of preprocessing error detection routines. Wilson (1993) adapted an outlier detection method from multivariate statistics, which calculates the volume of the space spanned by the remaining basis when removing n observations from the sample. Grosskopf et al (1990) used bootstrapping techniques to assess DEA results. Magnussen (1996) used jackknife analysis to measure the robustness of calculated efficiency to outliers.

In contrast Nunamaker (1985) suggested a more transparent and more practical method for evaluating sensitivity and robustness to model changes, which is adopted in this research. The approach is essentially to investigate sensitivity and robustness by altering the specifications with respect to:

1. Virtual weights restrictions
2. Leaving out an output from the analysis
3. Leaving out an input from the analysis
4. Leaving out an efficient hospital from the analysis

6.3.6 Summary of DEA Model Specification and Research Methodology

DEA is based on a theoretical model of production, which defines the relationships between input and output variables. In order to express theoretical relationships in quantitative terms, it is necessary to specify the model in terms of the actual real world data that represent the variables suggested by the theory (Hollingsworth and Parkin 1998). In assessing the technical efficiency of hospitals, the DEA model specification for this research is summarized as follows:

1. Selected DMUs are the 75 general acute hospitals owned by the ministry of Health in Saudi Arabia. The data are averages for the period 1994 – 96

2a. The outputs selected are

- Discharges
- Inpatient days
- Surgical operations performed (major or minor)
- Number of surgical specialties provided
- Outpatient & Emergency Visits

2b. The inputs selected are

- Bed days available
- Surgical MDs
- Non-Surgical MDs
- Nurses
- Supporting Personnel

3. The model is Input minimization oriented
4. CCR and BCC models are both used in assessing hospitals efficiency

5a Weight restrictions are examined and imposed

5b Weights are selected and imposed

5c Sensitivity and robustness to model variations are evaluated

Descriptive analyses of the inputs and outputs are presented. Constant and variable returns to scale unrestricted DEA models are used and results are analyzed for efficient and inefficient units. Weights restrictions are derived from the unbounded models and their effects are tested before selecting a final set of weights. The weight restricted model is then applied and tested for robustness and sensitivity to changes in inputs, outputs or to omissions of efficient units.

The results from the final DEA model are then used to examine the differences in efficiency between contract and traditional management of hospitals.

Figure 6.1, partially adapted from Golany and Roll (1989), summarizes the research framework of this section of the study:

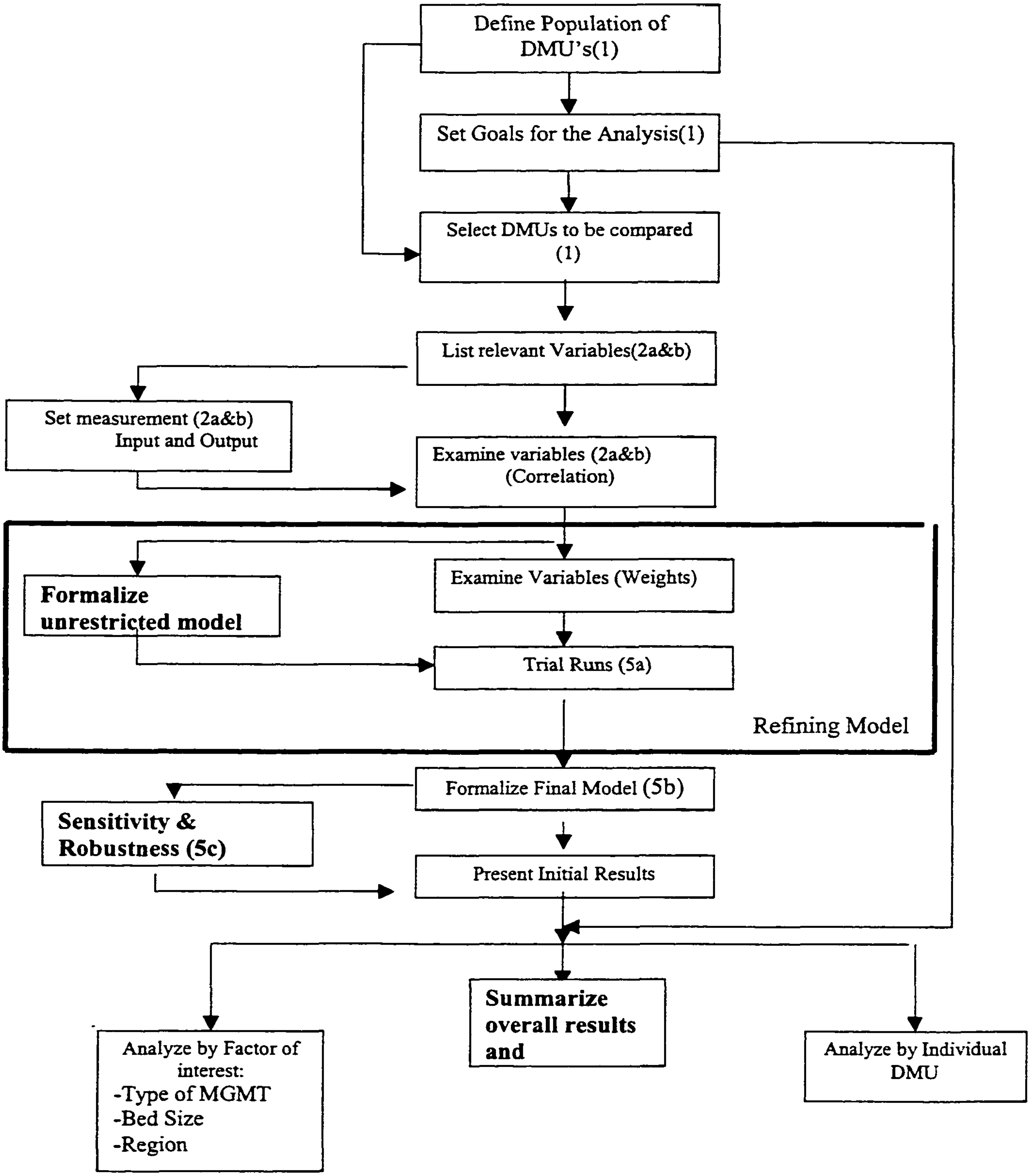

Figure 6.1: DEA modeling process

The DEA analysis was performed using specially designed software package developed by Banxia Software called Frontier Analyst.

6.4 Analyses

6.41 Descriptive analysis

The purpose of this section is to identify the distributional characteristics of each of the variables to be used in the technical efficiency assessment. Table 6.2 summarizes the descriptive statistics for each variable, presenting the mean, standard (STD) deviation, coefficient of variation (C.V.), minimum and the maximum values.

	N	Minimum	Maximum	Mean	Std. Deviation	Coefficient of Variation
Output Variables						
DISCHARGES	75	2062	46147	10541.71	6746.56	64%
INPATIENTDAYS	75	9225	250889	53943.9	45612.3	85%
OP-EM VIST	75	50821.33	380537.67	169038.65	84254.37	50%
SURG_TYP	75	6.00	18.67	13.12	2.65	20%
SURGMAJR	75	157.33	13605.33	2093.77	2217.27	106%
SURGMINR	75	142.00	4683.33	1330.24	1074.28	81%
Input Variable						
BED DAYS	75	17700.00	317656.00	76784.96	57525.49	75%
NON-SURGICAL MDs	75	11.00	556.00	75.23	89.35	119%
SURGEONS	75	2	104	17.57	16.60	94%
NURSES	75	30	905.00	214.7	198.3	92%
NMSTF	75	51	2204	404.05	391.30	97%

Table 6.2: Descriptive Statistics for all Hospitals

The data set exhibits similar variations on all the output variables except the number of surgical specialties with a very relatively low CV (20 %), and the number of major surgical operations which has relatively high CV (106%). The input variables also exhibit similar variation levels except the number of non-surgical MDs with a relatively high CV (119%).

Some of these variations reflect differences in hospitals size. When output and input varjiables variations among the large and small hospitals are examined separately (table 6.3), the coefficients of variation are generally lower than those in table 6.2.

		N	Mean	Std. Deviation	C.V.%
Small	Output Variables				
	DISCHARGES	38	6164.31	2179.63	35
	Inpatient days	38	23999.37	8762.98	37
	OP-EM VIST	38	115466.2	52966.56	46
	SURG_TYP	38	11.65	1.84	16
	SURGMAJR	38	887.86	520.1	59
	SURGMINR	38	955.14	949.8	99
	Input Variable				
	BED DAYS	38	37194.84	10987.42	30
	NON-SURGICAL MDs	38	28.82	13.18	46
	Surgeon's	38	8.55	6.07	71
	NURSES	38	87.47	35.84	41
	NMSTF	38	198.76	96.36	48
Large Hospitals	Output Variables				
	DISCHARGES	37	15037.41	6905	46
	Inpatient days	37	84697.69	47739.53	56
	OP-EM VIST	37	224059	74617.72	33
	SURG_TYP	37	14.63	2.51	17
	SURGMAJR	37	3332.27	2591.56	78
	SURGMINR	37	1715.48	1069.61	62
	Input Variable				
	BED DAYS	37	117445.1	57658.55	49
	NON-SURGICAL MDs	37	122.89	107.8	88
	Surgeon's	37	26.84	18.83	70
	NURSES	37	345.43	211.71	61
	NMSTF	37	614.89	463.7	75

Table 6.3: Descriptive Statistics for Small and big Hospitals

Moreover, as can be seen from table 6.4, almost all the variables are significantly correlated (at the .01 level); which is to be expected since they are all associated with level of hospital production function. However the number of minor surgical operations is not correlated with the number of surgeons, the nonsurgical MDs or the number of surgical specialties but significantly correlated with the number of nursing staff. This may indicate that this variable includes minor surgical procedures that involve nursing staff more heavily than medical staff.

Variables	DISCHARGES	INPDAYS	OPEMVIST	SURG_TYP	SURGMAJR	SURGMINR	BEDDAYS	NONSURGICAL MDs	SURGEONS	NURSES
INPDAYS	0.8412									
	0.0000									
OPEMVIST	0.7242	0.6723								
	0.0000	0.0000								
SURG_TYP	0.6104	0.6146	0.4593							
	0.0000	0.0000	0.0000							
SURGMAJR	0.8515	0.9002	0.6357	0.5630						
	0.0000	0.0000	0.0000	0.0000						
SURGMINR	0.3104	0.3254	0.4636	0.1131	0.2795					
	0.0067	0.0044	0.0000	0.3340	0.0152					
BEDDAYS	0.7348	0.9648	0.6451	0.6182	0.8409	0.3265				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0043				
NONSURGMDs	0.5505	0.8286	0.5257	0.4688	0.7702	0.1695	0.8689			
	0.0000	0.0000	0.0000	0.0000	0.0000	0.1459	0.0000			
SURGEONS	0.4903	0.8075	0.5144	0.4754	0.7359	0.1440	0.8565	0.9193		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.2178	0.0000	0.0000		
NURSES	0.7302	0.9191	0.6656	0.6206	0.8365	0.3009	0.9447	0.8877	0.8161	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0087	0.0000	0.0000	0.0000	
NMSTF	0.6277	0.8549	0.5558	0.4873	0.7853	0.2081	0.8843	0.8669	0.8333	0.8990
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0732	0.0000	0.0000	0.0000	0.0000

Table 6.4: DEA Inputs and Outputs Correlations

6.4.2 Unrestricted Model

Unrestricted models measure technical efficiency with total flexibility of selecting weights. Using the inputs and outputs defined in the previous section, technical efficiency was measured for each hospital utilizing the CCR and BCC input oriented models with total flexibility of weights. The efficiency measures are computed relative to the best practice frontier constructed from the data set. Therefore, these values represent a relative and not an absolute measure of efficiency.

6.4.2.1 Unrestricted CCR Model

Of the 75 hospitals included in the study 25 had an efficiency ratio of 100 and were identified as relatively efficient. The remaining 50 were inefficient because their efficiency scores were less than 100. The overall mean efficiency score was 86.4 % with a standard deviation of 14.2, a minimum score of 55.41 and a median of 90.4. The means of input and output variables for both the efficient and inefficient hospitals are presented in table 6.5.

Comparing the five inputs between the efficient and inefficient hospitals show that on average the efficient hospitals have inputs which are all under 62% of the average inputs for the inefficient hospitals. Hence the efficient hospitals tend to be smaller with an average of 154 beds, whereas inefficient hospitals tend to be larger with an average of 248 beds.

	Efficient		Inefficient	
Variables	**N**	**Mean**	**N**	**Mean**
Outputs				
Inpatient days	25	43471.6 (42605.1)	50	59180 (46572)
DISCHARGES	25	9720.8 (8836.5)	50	10952.2 (5457.2)
OPEMVISTS	25	151748 (90371)	50	177683.9 (80571)
SURG_TYP	25	12 (2.97)	50	13.7 (2.3)
SURGMAJR	25	1794 (2638.7)	50	2243.7 (1986.4)
SURGMINR	25	1571 (1288.1)	50	1209.8 (941.2)
Inputs				
BED DAYS	25	54511.3 (42318.7)	50	87921.8 (61161.3)
SURGEONS	25	11 (8.99)	50	20.8 (18.6)
NONSURGMDs	25	40.6 (39.6)	50	92.5 (101.8)
NURSES	25	129.4 (132)	50	257.4 (212.7)
NMSTF	25	207 (213.2)	50	502.6 (423.4)

Table 6.5: Input Output Mean (STD) of Efficient and Inefficient Hospitals

Input and output contributions to the relative efficiency scores are measured by the virtual weights accorded to each of them by the DEA model (table 6.6). They give an indication of the aspects of performance on which units appear stronger (Thanassoulis et al 1987). The bed days variable was the most dominant input variable with a mean weight of 80.8%, followed by nursing staff with a mean weight of 61.4 %. Inpatient days was the most dominant output with a mean weight of 60.5 %, followed by discharges with a mean weight of 47.4%.

	Small Hospitals				Large Hospitals				All Hospitals			
	Mean	Std. Deviation	# Times Used	# Times Dominant	Mean	Std. Deviation	# Times Used	# Times Dominant	Mean	Std. Deviation	# Times Used	# Times Dominant
INPDYS	38.1	12.9	14	3	70.6	27.8	31	24	60.5	28.4	45	27
DISCHARGES	49.8	28.4	18	7	41.1	32.6	7	3	47.4	29.2	25	10
OPEMVISITS	37.7	36.4	8	2	20.1	18.1	11	1	27.5	27.9	19	3
SURG-TYPE	42.3	25.7	31	9	18.6	13.6	12	0	35.7	25.2	43	9
SURGMJR	28.6	24.5	20	4	45.5	26.6	15	4	35.9	26.5	35	8
SURGMNR	61.3	31.8	3	2	6.8	7.2	14	0	16.4	25.1	17	2
BEDDAYS	80.3	21.1	23	20	81.2	24.8	27	22	80.8	22.9	50	42
SURGEONS	29.7	27.3	22	4	27.4	29.7	17	4	28.7	28	39	8
NONSURGICAL MDs	25	28.6	15	3	27	31.3	8	1	25.7	28.9	23	4
NURSES	66.4	34.7	10	7	55.6	39.6	9	5	61.3	36.5	19	12
NMSTF	32.5	37.9	8	2	32.7	37.7	10	3	32.6	36.7	18	5

Table 6.6: Virtual Weight Descriptive Statistics by Hospital Size group
Mean and STD calculated by excluding zero values.

Analyzing the DEA results for the 14 least efficient hospitals (scoring below 70) showed these hospitals were mostly large size hospitals, with 86% of them over the median size of 150 beds.

Examining the efficient reference sets for the inefficient hospitals, shows the efficient hospitals that most closely resemble the inefficient hospital with regard to input and output mix. 18 out of the 25 efficient hospitals were used as references for the inefficient hospitals, and the majority of the referenced hospitals (14) were small (< 150 beds).

However a reference set may consist of many efficient hospitals, but the importance of the reference set lies on the contribution of each hospital in the reference set in forming the target values for each of the inefficient hospital's inputs and outputs. The 5 most referenced hospitals were 74 (85 beds), 52 (502 beds), 59 (100 beds), 80 (50 beds) and 56 (194 beds).

These finding suggests that, as expected CCR is influenced by the most efficient scale size (i.e. less than 150 beds), hence CCR efficiency includes both technical and scale components of efficiency, with smaller hospitals generally being more efficient.

This is in contrast to the usual argument in the literature that hospital services are produced subject to economies of scale (Berry 1967).

6.4.2.2 Unrestricted BCC Model

Relaxing the restriction of constant return to scale inherent in the CCR model allows hospital's technical efficiency to be measured relative to hospitals of similar scale size, rather than the best performance of all hospitals. The BCC model is a modified form of CCR that incorporates variable returns to scale by adding a new constraint to change the reference set from a cone in the case of CCR to a convex hull, where a hospital is compared to a limited number of combinations. Therefore the chance of getting a higher efficiency score is greater, and more hospitals are likely to be found efficient under the BCC model than under the CCR model.

Under the BCC model, Of the 75 hospitals included in the study, 41 were identified as relatively efficient and 34 as inefficient. Because scale size is considered in the calculation of relative efficiency, 11 more large hospitals and 5 more small ones became efficient under BCC model, in addition to the 25 efficient hospitals under the CCR model. As a result of the nature of the BCC model, efficient hospitals on average had a higher average size measured in terms of beds, which turned out to be 207 beds, compared with 154 for CCR model.

The overall mean efficiency score was 91.8 % with a standard deviation of 11.6, a minimum score of 58.95 and a median of 100. The means of input and output variables for both the efficient and inefficient hospitals are presented in table 6.7. In contrast to the CCR model (see table 6.5), the efficient and inefficient hospitals are now much more similar in size, as is to be expected.

	Inefficient		Efficient	
Variables	**N**	**Mean**	**N**	**Mean**
Inpatient days	34	51422.9 (38202)	41	56034.4 (51332.3)
DISCHARGES	34	9605.34 (4292.6)	41	11318 (8224.4)
OPEMVIST	34	159314.8 (69574.9)	41	177102.4 (94827.3)
SURG_TYP	34	12.95 (2.1)	41	13.3 (3.1)
SURGMAJR	34	1981.9 (1823.2)	41	2186.5 (2516.6)
SURGMINR	34	1066.5 (825.6)	41	1548.9 (1210.2)
BEDDAYS	34	80739.8 (53329)	41	73505.4 (61248.5)
SURGEONS	34	20.9 (19.2)	41	14.8 (13.8)
NONSURGICALMDs	34	86.9 (98.9)	41	65.5 (80.6)
NURSES	34	277.7 (173.3)	41	204 (218.4)
NMSTF	34	464.4 (332.1)	41	354 (432)

Table 6.7: Input Output Mean (STD) of Efficient and Inefficient Hospitals

Looking at the input and output contributions to the relative efficiency scores of all hospitals (table 6. 8), bed days remained the most dominant input variable with a mean weight of 75.8%. Surgical operation specialties (SURGTYPE) was the most dominant output with a mean weight of 56.6%, followed by Inpatient days and discharges with mean weights of 47% and 43.4% respectively.

	Small Hospitals				Large Hospitals				All Hospitals			
	Mean	Std. Deviation	# Times Used	# Times Dominant	Mean	Std. Deviation	# Times Used	# Times Dominant	Mean	Std. Deviation	# Times Used	# Times Dominant
INPDYS	46.4	30.7	13	5	47	32.8	21	9	47	31.5	34	14
DISCHARGES	48.7	28	16	8	30.2	30.2	6	2	43.7	29.2	22	10
OPEMV	44.6	39.7	11	4	30.1	29.2	20	4	35.2	33.4	31	8
SURGTYPE	50.8	25.7	24	13	63.4	31.8	20	12	56.5	28.9	44	25
SURGMJR	32.3	26.3	14	3	44.1	39.1	8	3	36.6	31.2	22	6
SURGMNR	32	33	8	2	15.4	19.6	19	2	20.3	24.9	27	4
BEDDAYS	80	23.3	22	19	69.1	33.5	15	12	75.8	28	37	31
SURGEONS	42.7	34.3	20	8	55.4	34.6	11	4	47.2	34.4	31	12
NONSURGICAL MDs	17.9	24	8	1	71.3	29.9	8	5	44.6	38.1	16	6
NURSES	53.9	36.8	12	5	69.4	37.1	9	6	60.6	36.8	21	11
NMSTF	43	41.2	9	3	78	39.6	11	9	62.3	43.1	20	12

Table 6.8: Input and Output contributions in calculating the relative efficiency scores

When the contributions for small and large hospitals are compared bed days input is still an important variable. However for large hospitals the other input variables are now making similar contributions. On the output side surgery type is the most dominant variable for both small and large hospitals. However, there are also even contributions across all the output variables than was the case for the CCR model.

Analyzing the DEA results for the ten least efficient hospitals (with efficiency scores ranging between 59% and 75%) shows that hospital sizes were a mixture of small and large ranging from 107 to 719 beds. This is in contrast to the CCR model where large hospitals dominated the least efficient group.

In examining the efficient reference sets for the inefficient hospitals, it was found that, 32 out of the 41 efficient hospitals were used. In contrast to the CCR model, these were divided equally between small and large hospitals. The 5 most referenced hospitals were 74 (85 beds), 52 (502 beds), 56 (194 beds), 58 (150 beds) and 38 (50 beds). However the two most referenced hospitals were the same under the CCR and BCC models, i.e. hospitals 74 and 52.

6.4.3 Restricted Model

A major drawback of the unrestricted model is ignoring some of the inputs and outputs in the calculation of relative efficiency. As a result the relative efficiency of a hospital may not reflect its performance on the inputs and outputs as a whole. It has been shown in the previous section that input and output variables had widely varying patterns of weights associated with the basic DEA model. Moreover variables vary in the number of times they have been used in the efficiency calculation, table 6.9 illustrates the distribution of the number of variables used in the efficiency calculations, showing that none of the hospitals efficiency scores have been calculated using more than eight of the eleven variables.

No. of Variables	2	3	4	5	6	7	8	9	10	11
CCR Count	3	11	27	22	8	4	0	0	0	0
BCC Count	7	18	23	20	5	2	1	0	0	0

Table 6.9:The number of variables used in the efficiency calculations

A restricted DEA model is an alternative way to discriminate between relatively efficient units and eliminate those relying on an inappropriate weighting structure (Boussofiane et al 1991). However in a broader context weight restrictions can be used to obtain efficiency measures that are more compatible with real life applications by incorporating the perceived values of inputs and outputs. By placing constraints on the relative weights, the region of search for those weights are reduced, so a hospital's efficiency cannot increase as a consequence.

In this study weight restrictions have been introduced by attaching lower weight bounds to the virtual inputs and outputs. Following the approach presented in section 6.3.5.1 20 sets of weights were developed utilizing the minimum and mean weights of the unrestricted CCR and BCC models for each variable by applying different alterations, to determine the impact of a range of weight restriction options. Table 6.10 summarizes the weight model sets and model codes. For example weight model 1 (m1) is the nonzero minimum weight under the unrestricted CCR model, m2 is the nonzero minimum weight under the unrestricted BCC model. Model codes m3-m14 are alterations of the minimums (m1 and m2). Model codes m15- m20 are alterations of the mean weight (after excluding zero and 100 % weight values) of the CCR and the BCC unrestricted models.

A summary of the relative efficiency results is shown in table 6.11. Both the CCR and BCC models have similar patterns with Weight restrictions (Figure 6.2). Weight restriction models 15,16,17 and 18 are alterations of the mean weights, and were the most restrictive with the lowest mean efficiency scores and lowest numbers of efficient hospitals for the CCR and BCC models. It was also found that all Bonferroni multiple comparisons were not significant except models 15,16,17 and 18 for both CCR and BCC models that were the significantly different models with a mean difference significant at the level .01. The result provides evidence of the differences between very restrictive weights and fairly moderate weights that barely restrict the DEA model. Using the unrestricted model mean weights for deriving the weight sets seems to heavily limits the opportunities for the hospital to achieve the maximum efficiency rating feasible for it's inputs and outputs level, which is considered a change in the properties of the DEA model (Podinoviski 1999).

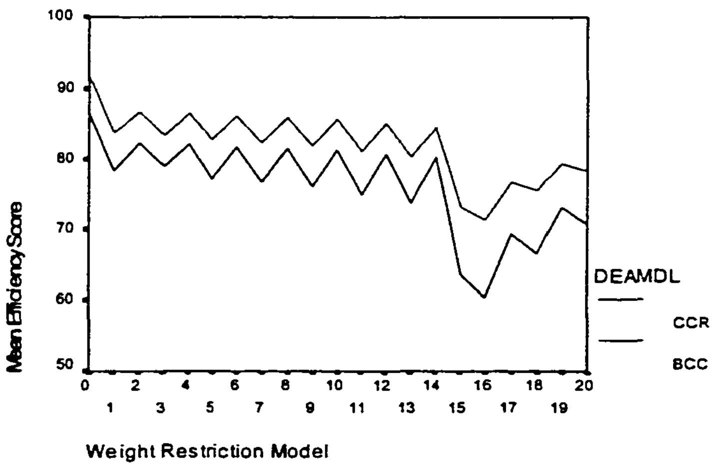

Figure 6.2: Weight restrictions models results

Model 0 is the unrestricted model

Reviewing the hospitals efficiency status changes over the weight models shows that only one hospital was consistently efficient across all CCR weight restricted models, hospital 74 with 85 beds, while 13 hospitals were consistently efficient across the BCC weight restricted models divided equally between small and large hospitals. When excluding the most restrictive models (15 and 16), hospitals 58, 59,74 and 88 were consistently efficient across all other CCR weight models and 16 hospitals across the BCC model. This suggests that their rating as efficient is robust to the weight restrictions. These hospitals were also among the most frequently referenced hospitals for both CCR and BCC unrestricted models.

However a number of efficient hospitals lost their efficiency when weight restrictions were imposed. Although they were frequently referenced by other hospitals, their efficiency was strongly dominated by either one input or one output, and in some case only one input and one output. A good example is hospital 62 (119 beds) that was referenced 23 times under the CCR unrestricted model and 13 times under the BCC unrestricted model. Its efficiency was strongly dominated by one input under CCR model and one output under the BCC model, after restricting the weights the hospital is no longer efficient.

Another two examples are hospitals 52 and 56, which were referenced 29 and 30 times respectively under the CCR model but their efficiency were based on one input and one output. The change in the status of these hospitals came from altering the weights against the dominating variables on their efficiency. In contrast hospital (88) with an efficiency score based on multiple inputs and outputs (a total of 8 variables) maintained consistent efficiency status over the weight models. As expected, this provides evidence that weight restriction helps in eliminating hospitals relying on an inappropriate weighting structure.

Models	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20
BEDDAYS	18.00	9.00	18.90	9.45	19.80	9.90	20.70	10.35	21.60	10.80	23.40	11.70	25.20	12.60	18.52	16.38	14.82	13.11	12.35	10.92
SURGEONS	1.00	3.00	1.05	3.15	1.10	3.30	1.15	3.45	1.20	3.60	1.30	3.90	1.40	4.20	6.22	8.64	4.97	6.91	4.14	5.76
NONSURGICAL MDs	3.00	3.00	3.15	3.15	3.30	3.30	3.45	3.45	3.60	3.60	3.90	3.90	4.20	4.20	4.65	7.94	3.72	6.35	3.10	5.29
NURSES	12.00	2.00	12.60	2.10	13.20	2.20	13.80	2.30	14.40	2.40	15.60	2.60	16.80	2.80	13.50	10.21	10.80	8.17	9.00	6.81
NMSTF	1.00	2.00	1.05	2.10	1.10	2.20	1.15	2.30	1.20	2.40	1.30	2.60	1.40	2.80	6.05	6.15	4.84	4.92	4.03	4.10
DISCHARGES	5.00	1.00	5.25	1.05	5.50	1.10	5.75	1.15	6.00	1.20	6.50	1.30	7.00	1.40	11.29	9.51	9.03	7.61	7.53	6.34
INPDYS	3.00	7.00	3.15	7.35	3.30	7.70	3.45	8.05	3.60	8.40	3.90	9.10	4.20	9.80	14.16	9.99	11.33	7.99	9.44	6.66
OPEMV	1.00	1.00	1.05	1.05	1.10	1.10	1.15	1.15	1.20	1.20	1.30	1.30	1.40	1.40	5.88	7.07	4.70	5.66	3.92	4.71
SURGTYPE	5.00	1.00	5.25	1.05	5.50	1.10	5.75	1.15	6.00	1.20	6.50	1.30	7.00	1.40	8.13	13.34	6.51	10.67	5.42	8.89
SURGMJR	1.00	3.00	1.05	3.15	1.10	3.30	1.15	3.45	1.20	3.60	1.30	3.90	1.40	4.20	8.00	9.15	6.40	7.32	5.33	6.10
SURGMNR	2.00	1.00	2.10	1.05	2.20	1.10	2.30	1.15	2.40	1.20	2.60	1.30	2.80	1.40	4.10	4.31	3.28	3.45	2.74	2.87

Table 6.10: Weight Model sets

Model codes:

m1 ccr min
m2 bcc min
m3 ccr min*1.05
m4 bcc min*1.05
m5 ccr min *1.1
m6 bcc min*1.1
m7 ccr min* 1.15
m8 bcc min*1.15
m9 ccr min*1.2
m10 bcc min* 1.2
m11 ccr min*1.3
m12 bcc min*1.3
m13 ccr min*1.4
m14 bcc min*1.4
m15 ccr mean*1/4
m16 bcc mean * 1/4
m17 ccr mean* 1/5
m18 bcc mean *1/5
m19 ccr mean * 1/6
m20 bcc mean * 1/6

DEA Model	Weight Model	N	Mean	Std. Deviation	Minimum Score	# Efficient Hospitals
CCR	0	75	86.37	14.22	55.41	25
	1	75	78.27	16.66	47.86	14
	2	75	82.27	15.21	52.71	18
	3	75	78.80	16.69	48.05	14
	4	75	82.03	15.28	52.36	16
	5	75	77.19	17.06	46.60	13
	6	75	81.77	15.35	52.02	16
	7	75	76.61	17.21	45.99	12
	8	75	81.52	15.42	51.68	16
	9	75	76.03	17.36	45.40	12
	10	75	81.26	15.50	51.35	16
	11	75	74.87	17.66	43.95	11
	12	75	80.73	15.67	50.69	16
	13	75	73.71	17.94	42.08	10
	14	75	80.20	15.85	50.04	15
	15	75	63.62	17.77	29.05	1
	16	75	60.29	18.04	23.86	1
	17	75	69.26	17.79	35.81	4
	18	75	66.45	18.22	30.33	4
	19	75	73.09	17.69	40.43	6
	20	75	70.68	18.02	36.27	4
BCC	0	75	91.83	11.62	58.95	41
	1	75	83.65	15.58	48.45	24
	2	75	86.66	14.39	53.69	29
	3	75	83.18	15.79	47.88	24
	4	75	86.39	14.52	53.27	29
	5	75	82.71	15.99	47.31	23
	6	75	86.12	14.65	52.86	29
	7	75	82.27	16.16	46.73	23
	8	75	85.84	14.78	52.42	28
	9	75	81.85	16.34	46.14	23
	10	75	85.57	14.90	51.95	28
	11	75	81.02	16.68	44.93	23
	12	75	85.04	15.15	51.05	27
	13	75	80.21	17.05	43.69	21
	14	75	84.48	15.39	50.18	27
	15	75	73.03	19.64	36.67	14
	16	75	71.36	20.33	32.71	13
	17	75	76.69	18.49	40.02	16
	18	75	75.46	18.99	38.63	16
	19	75	79.24	17.76	42.83	17
	20	75	78.26	18.14	41.23	17

Table 6.11: Smmary of Weight Restriction Models

6.4.4 Formalizing Final Model

Imposing weight restrictions on the DEA model results in a downward shift in the frontier, and hence a decrease in relative efficiency scores for all hospitals. As was apparent from figure 6.2, the weights restrictions models had a similar patterns of impacts for both CCR and BCC. The Spearman's ranks correlations between the efficiency scores were all above .9 and statistically significant at the level .001, which suggests that the models are robust in some over all sense (Hollingsworth and Parkin 1998).

At the hospital level, the different weight models will have obviously cause some changes to the efficiency scores, and efficiency status of some hospitals. However the number of hospitals that were dramatically affected was low. For example, figures 6.3a and b show the lowest and highest scores (excluding the two most restrictive models M15 and M16) for each of the 75 hospitals. Even when using this extreme comparison, it can be seen that the two sets of scores tell much the same overall story in terms of whether hospitals are close to the efficiency frontier or a long way from it. For later reference, those hospitals that are most affected by choice of weights are listed in table 6.12.

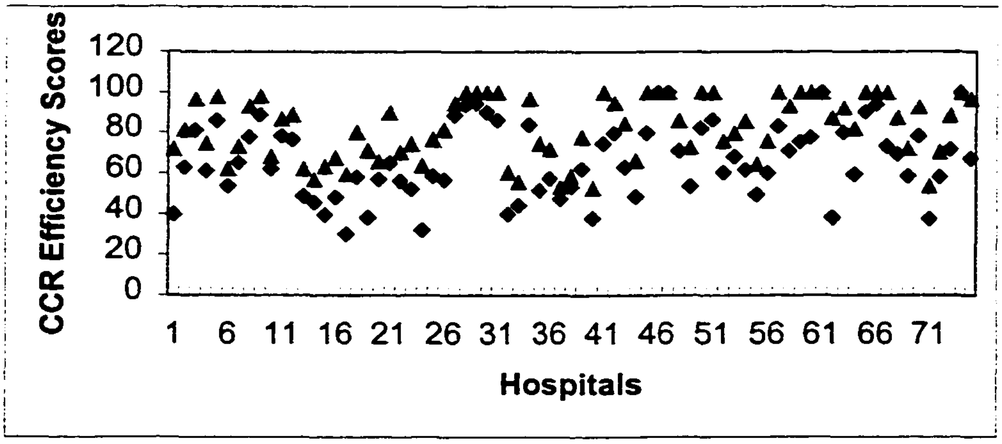

Figure 6.3a: CCR Weights Restriction Models Lowest and Highest Scores

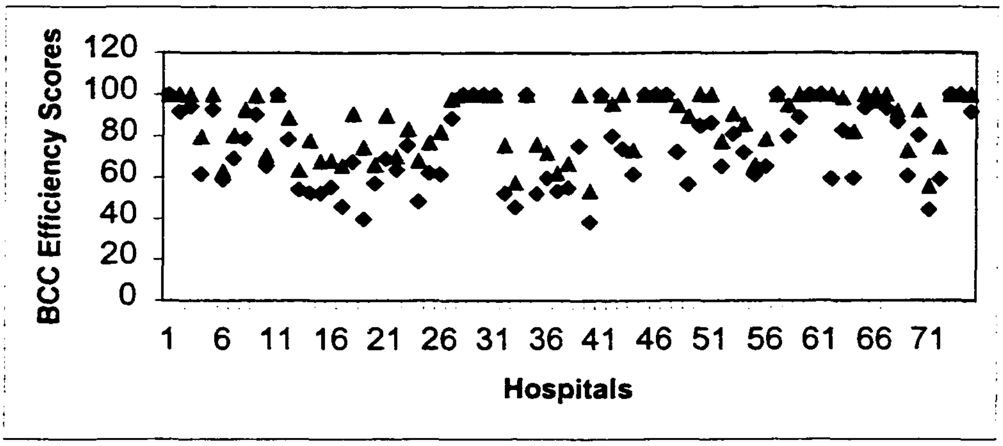

Figure 6.3b: BCC Weights Restriction Models Lowest and Highest Scores

DEA Model	Hospital	Mean Efficiency Score	Min score	Max score	Range
CCR	75	64.13	38.5	87.1	48.6
	25	58.28	38.4	71.2	32.76
	1	59.99	40	71.9	31.9
	32	50.09	32.3	63.8	31.5
	21	48.86	30.3	59.6	29.23
	19	55.04	39.9	63.3	23.49
	41	52.87	40.2	60.4	20.25
BCC	75	86.9	59.6	100	40.4
	25	61.98	39.9	74.7	34.8
	61	71.68	56.8	89.6	32.81
	17	66.03	52.8	77.9	25.1
	45	67.68	52.3	75.9	23.7
	41	64.4	52.5	75.7	23.2
	77	74.23	59.9	82.2	22.3

Table 6.12 : Hospitals with highest changes in the efficiency scores

In this light the average weight restrictions of all the models (excluding models 15 and 16) for each variable have been used to form the finalized BCC and CCR models which will be used as the focus of analyses in the subsequent sections. Weight lower bounds applied for each variable are presented in table 6.13.

Input Variables	Weight lower bound	Output Variables	Weight lower bound
Bed days	15.14	Discharges	4.43
Surgeons	3.03	Inpatient days	6.52
Non Surgical MDs	3.76	OPEM visits	1.97
Nurses	8.3	Surgery type	4.48
NMSTF	2.4	Surgery major	3.22
		Surgery minor	2.05

Table 6.13: Weight Lower Bounds for Finalized Models

6.4.5 Sensitivity and Robustness of the Finalized DEA model

Previous sections have looked at the results of the DEA model with regard to differences in returns to scale and virtual weight restrictions. To carry the DEA results further into more analyses, the finalized DEA model has to be tested for sensitivity and robustness. As has been discussed in section 6.3.5.2, DEA is a non-stochastic method, which makes the results sensitive to measurement error and variable selection. Therefore a sensitivity and robustness analysis has been carried out by subjecting the DEA model to changes in the specifications through changing the data set (leaving out one output or leaving out one input) or leaving out an efficient hospital from the analysis. The purpose is to examine their impact on the DEA model results and the stability of the efficiency classification as efficient or inefficient hospital.

6.4.5.1 Robustness of DEA Results to Input – Output changes

The DEA model is evaluated by changing the input – output combinations through dropping one input or one output each run, which leads to 11 combinations for each DEA model (CCR and BCC). Table 6.14 shows the inputs and outputs included in each of the models M0 to M11.

	Models											
Variables	**M0**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**
Bed days	X	-	x	x	x	x	x	x	x	x	x	x
Surgeons	X	x	-	x	x	x	x	x	x	x	x	x
Non Surgical MDs	X	x	x	-	x	x	x	x	x	x	x	x
Nurses	X	x	x	x	-	x	x	x	x	x	x	x
NMSTF	X	x	x	x	x	-	x	x	x	x	x	x
Discharges	X	x	x	x	x	x	-	x	x	x	x	x
Inpatient days	X	x	x	x	x	x	x	-	x	x	x	x
OPEM visits	X	x	x	x	x	x	x	x	-	x	x	x
Surgery type	X	x	x	x	x	x	x	x	x	-	x	x
Surgery major	X	x	x	x	x	x	x	x	x	x	-	x
Surgery minor	X	x	x	x	x	x	x	x	x	x	x	-

Table 6.14: Inputs and Outputs included in each model
x: included
-: not included

Figure 6.4 shows that the effect of omitting input and output variables have very similar patterns for CCR and BCC models. However, for some of the inputs and outputs the effect is bigger on the CCR model.

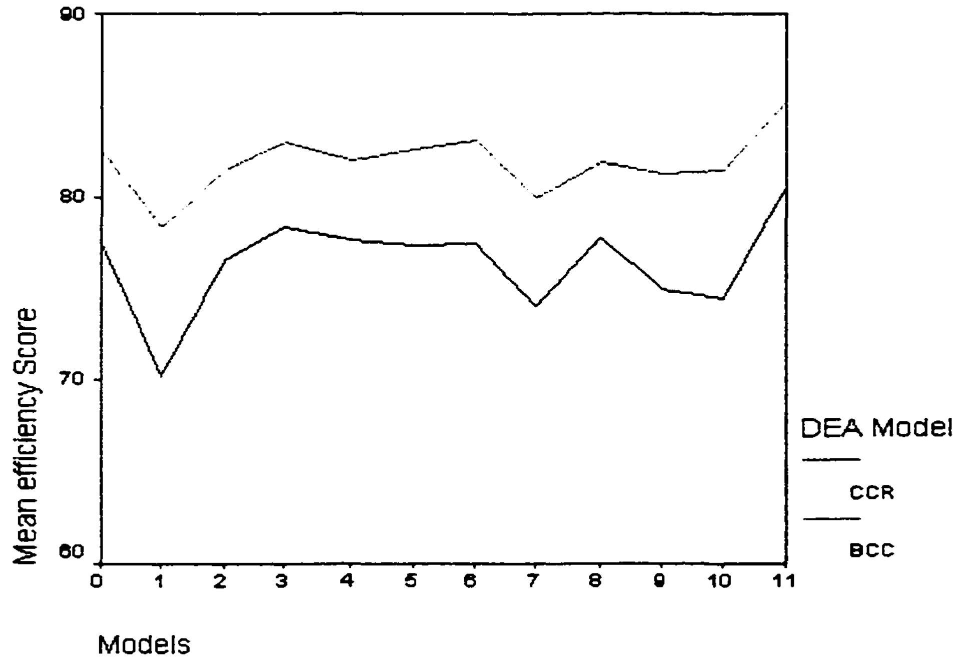

Figure 6.4 Sensitivity of mean efficiency scores to omission of inputs and outputs

Model M1, which excluded bed days from the analysis, has the lowest average efficiency score for both CCR and BCC models. Model M9, which excluded number of surgery types, also has a large impact on average efficiency score. Recall that bed days and number of surgery types were dominating variables in the efficiency calculation under both the CCR and BCC models. Table 6.15 shows the summary of the results generated from the data under the different input – output combination models.

Models		CCR				BCC			
Model	N	Mean	Std. Deviation	Min	# Efficient Hospitals	Mean	Std. Deviation	Min	# Efficient Hospitals
M0	75	77.38	16.94	46.89	13	82.42	16.27	47.21	24
M1	75	70.24	20.74	33.27	10	78.40	19.88	37.21	23
M2	75	76.53	16.74	47.38	12	81.45	16.17	47.71	21
M3	75	78.42	16.53	48.05	14	82.93	15.93	48.18	23
M4	75	77.64	17.32	47.88	13	81.94	17.17	47.9	25
M5	75	77.32	16.58	47.54	10	82.53	16.02	47.74	22
M6	75	77.40	16.84	47.6	13	83.06	15.88	47.96	22
M7	75	73.98	19.16	37.19	13	79.99	17.88	40.68	21
M8	75	77.77	16.41	47.69	13	81.82	16.12	47.84	19
M9	75	74.86	16.31	47.21	10	81.27	16.60	47.37	22
M10	75	74.41	16.77	43.44	10	81.48	16.44	46.54	23
M11	75	80.56	15.62	49.1	14	85.08	15.64	49.8	25

Table 6.15:Results generated from the data under the different input – output combination models.

At the hospital level there were very few dramatic changes on the hospitals' efficiency scores caused by changes in the input output combinations under both the CCR and BCC models. Even when the most extreme changes are considered, as shown in figures 6.5a and b, the patterns of relative scores and rankings across hospitals are very strong. The correlations between the models were all very high and highly significant, which suggests that the models are robust (Hollinsgworth and Parkin 1998).

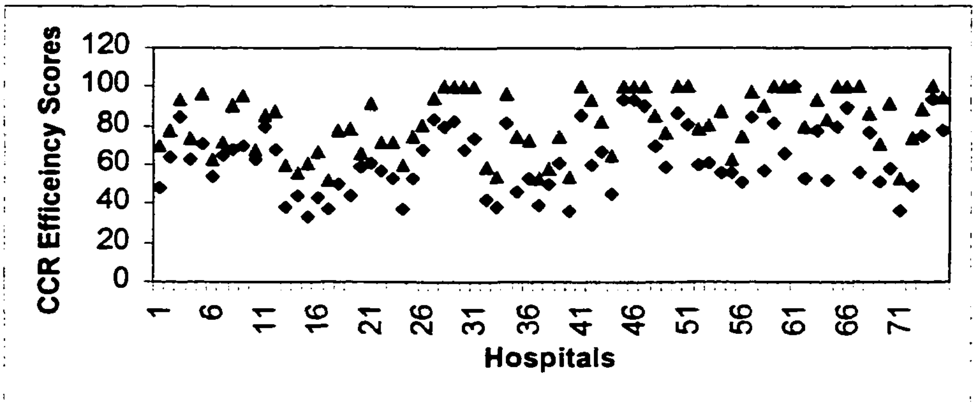

Figure 6.5a: CCR Input and Output Sensitivity Models Lowest and Highest Scores

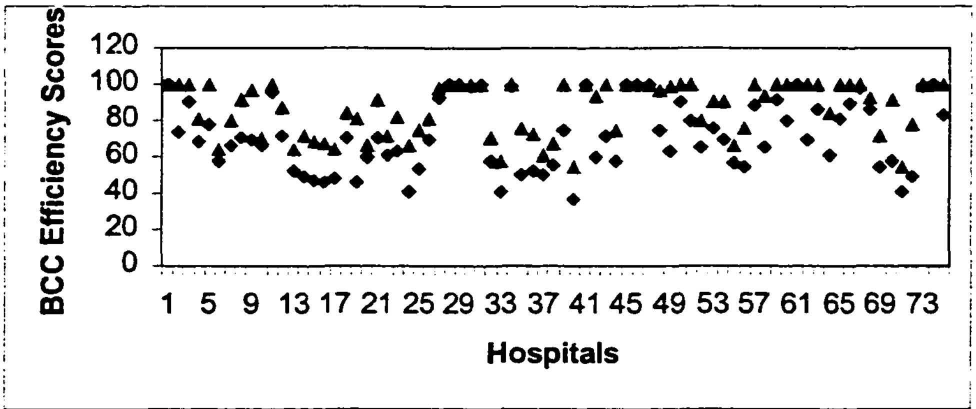

Figure 6.5b: BCC Input and Output Sensitivity Models Lowest and Highest Scores

In reviewing the impacts of changing the input – output combinations, stability of classification of hospitals as either efficient or inefficient, was investigated. Under the CCR model 73% of hospitals and under BCC 72% of hospitals had stable classification across all the models . Hospitals whose classification changed were mainly efficient hospitals that had fluctuations in their scores only when a dominating variable in their efficiency score calculation was taken out of the model. The most frequently referenced efficient hospitals had stable classifications across all the models.

6.4.5.2 Robustness of DEA Results to Omission of Efficient Hospitals

A DEA efficiency frontier is formed by the outer frontier of all hospitals. However there are no direct ways under DEA of assessing whether a hospital's deviation from the frontier is statistically significant (Smith and Mayston 1987). To evaluate the robustness of the efficiency frontier, analysis of the sensitivity of the DEA models to efficient hospitals should be carried out. Efficient hospitals are on the frontier; therefore their efficiency is not effected by removing an efficient hospital from the analysis. However an inefficient hospital may have a change in its efficiency level when an efficient hospital in its reference set is removed.

Robustness of DEA results to omitting an efficient hospital has been carried out by removing one at a time the 5 most frequently referenced hospitals. These happened to be the same hospitals under both CCR and BCC models, i.e. hospitals 74,52,56,62 and 80. These are referred to as models O (all hospitals included), A (hospital 74 omitted), B (hospital 52 omitted), C (hospital 56 omitted), D (hospital 62 omitted) and E (hospital 80 omitted).

Figure 6.6 shows that the effects of omitting the efficient hospitals have very similar patterns for CCR and BCC models.

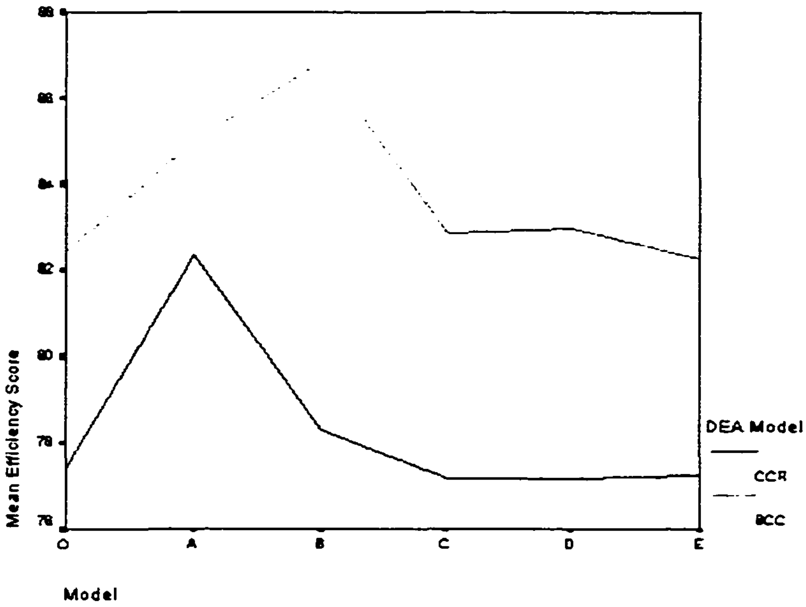

Figure 6.6 Sensitivity of mean efficiency scores to omission of efficient hospitals

Table 6.16 shows the summary of the results generated from the data under the different models. Removing efficient hospital 74 (85 beds) had the greatest effect on the results of CCR model, while removing efficient hospital 52 (502 beds) has the greatest effect on the BCC models.

		CCR				BCC			
Model	**N**	**Mean**	**Std. Deviation**	**Min**	**# Efficient Hospitals**	**Mean**	**Std. Deviation**	**Min**	**# Efficient Hospitals**
O	75	77.38	16.94	46.89	13	82.42	16.27	47.21	24
A	74	82.32	15.92	51.37	20	85.01	15.17	52.73	25
B	74	78.32	16.69	46.93	13	86.85	15.70	47.62	34
C	74	77.17	16.89	46.88	13	82.86	15.99	47.2	24
D	74	77.17	16.89	46.88	13	82.98	15.94	47.21	24
E	74	77.26	16.88	46.88	12	82.30	16.23	47.21	24

Table 6.16: Summary results for models with Efficient Hospitals omitted

Figures 6.7a and b show that at the hospital level no dramatic changes in the inefficient hospitals' scores caused by omitting an efficient hospital under both the CCR and BCC models (efficient hospitals could not be affected by omitting any one of them because they all lie on the frontier line). Spearman's rank correlations between the efficiency scores were all above .94 and statistically significant at the level .001. The correlations were all very high and highly significant, which suggests that the models are robust (Hollinsgworth and Parkin 1998).

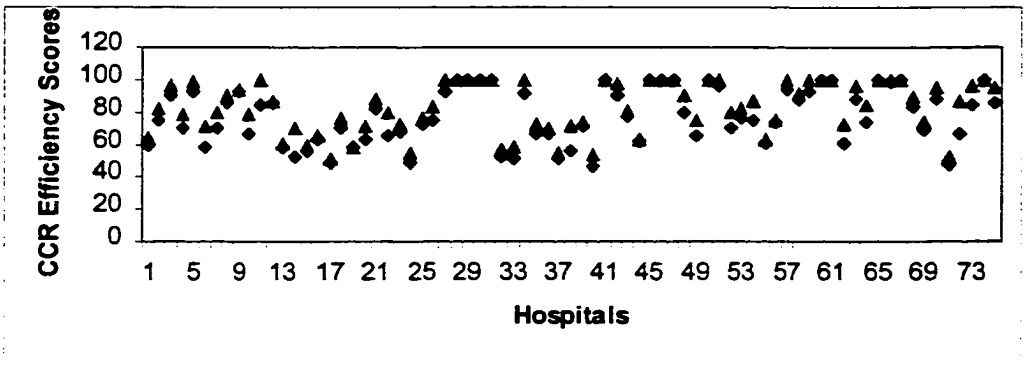

Figure 6.7a: CCR DMU Sensitivity Models Lowest and Highest Scores

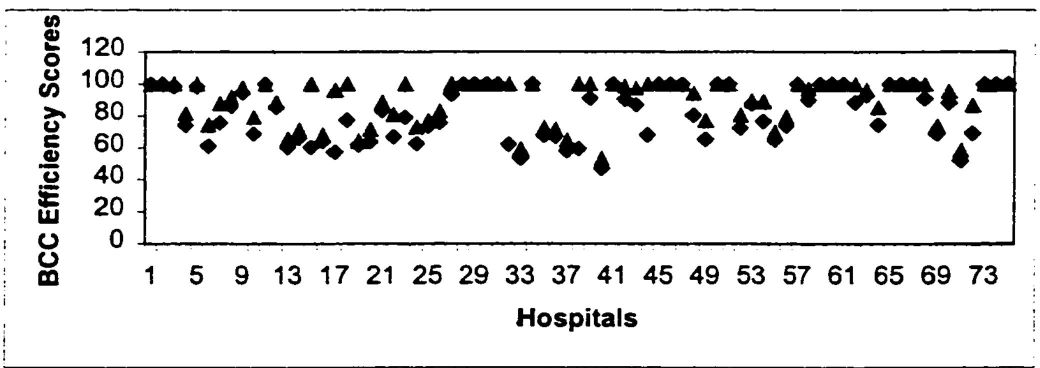

Figure 6.7b: BCC DMU Sensitivity Models Lowest and Highest Scores

In reviewing the impacts of omitting efficient hospitals, stability of classification of hospitals as either efficient or inefficient, was again checked. 89% and 85% of hospitals had stable classification across all the models under the CCR and BCC respectively. The only changes that occurred were when inefficient hospitals occasionally became efficient an efficient hospital was taken out of their reference sets.

6.4.6 Results from Finalized DEA Model

In the previous section, the final model has been formalized utilizing the inputs and outputs weight lower bounds, and tested for robustness to changes in the inputs and outputs sets and omission of efficient DMUs. Table 6.17 summarizes the results from the selected model, using all inputs and outputs and all DMUs.

Model	N	Mean	Std. Deviation	Minimum	#Efficient Hospitals	% of Efficient Hospitals
CCR	75	77.4	16.9	46.9	13	17
BCC	75	82.4	16.3	47.2	24	13
Scale Efficiency	75	0.94	0.041	0.84	-	-

Table 6.17: Summarry of the final model results

If hospitals are compared, making no allowances for either economies of scale or diseconomies of scale (i.e. CCR), 17% of hospitals are efficient. The average efficiency according to this model is 77.4%. Had they all been efficient, the same level of output could have been achieved with [(1/0.774)-1] 29.2% less inputs. However this would require hospitals to perform at a level of efficiency perhaps not possible at their current sizes, or for the sizes of hospitals to be changed to that of the optimum size, i.e. small. If on the other hand hospitals are compared in terms of pure technical efficiency, judged in comparison to similar sized hospitals (i.e. BCC), 32% of hospitals are now efficient. The average efficiency according to this model is 82.4%, implying the same level of output could have been achieved with [1/0.824) -1]

21.4% less inputs.

Under the CCR model efficient hospitals tend to be small (10 hospitals out of 13) as noted in section 6.4.2.1. The three large-scale hospitals which were efficient were hospitals 56,52 and 73 with 194, 400 and 500 beds. These 3 hospitals were fairly busy, with occupancy rates 81-98%. In contrast, of the 24 efficient hospitals under the BCC model 46% are large.

The reference set of an inefficient hospital is the set of hospitals to which it has been compared to when calculating its efficiency score. Table 6.18 shows the efficiency scores of each inefficient hospital and its reference set under both CCR and BCC. In the simplest cases, when an inefficient hospital has only one hospital in its reference est, e.g. hospital 35 only references hospital 74, the latter can suggest an example of good operating practice for the former. Where the reference set contains more than one efficient hospital, they can still be used as a guide for areas of potential improvement in the inefficient hospital.

Hospital	Efficiency CCR	Reference set	Unit	Efficiency BCC	Reference set
1	59.38	52,74			
3	74.81	52,74			
6	90.25	52,59,74	6	98.46	52,56,58,74
7	70.03	74,80	7	74.2	56,58,74,80
8	93.16	59,74,80	8	98.65	38,52,74
9	58.45	59,74,80	9	61.23	37,38,52,59,74
10	69.85	52,74,88	10	75.69	52,58,62,74
11	85.72	52,74	11	86.07	52,74,88
12	93.29	52,59	12	94.69	52,59,74
13	66.12	59,74,80	13	68.91	37,38,59,74
14	84.38	56,74			
15	85.11	52,59,74	15	85.61	38,52,59,74
16	58.74	52,56,74	16	60.51	52,56,69,74,78
17	51.8	52,74	17	66.02	74,87
19	56.32	52,74	19	60.43	52,56,58
20	62.52	52,74	20	64.16	52,74
21	48.21	52,74	21	57.49	52,56,73
22	70.22	52,62,74,88	22	77.45	52,58,62
25	57.7	58,74	25	61.87	38,58
26	63.36	52,74,88	26	64.06	52,63,74,89
27	81.76	52,74	27	83.61	52,56,74
28	64.81	74,80	28	67.03	37,40,74
29	67.67	56,73,74	29	79.19	44,52,56,73
32	48.36	52,74	32	62.72	52,56,73
33	73.04	52,59	33	73.58	52,56,59
35	74.9	74	35	75.74	74,88
36	92.65	52,56,59,74	36	93.7	52,56,58,74,87
40	99.4	39,74,80			
41	52.76	52,74	41	62.26	52,56,58
42	51.68	52,74	42	53.52	52,58,69,74
44	91.27	52,56,59,74			
45	67.13	74	45	67.94	56,74
46	66.73	52,56,74	46	67.22	38,52,74
47	51.64	52,62,74	47	58.14	52,56,58
48	56.22	52,59,74,80	48	59.51	52,56,58
50	71.88	52,59,74	50	91.14	52,56,58
51	46.89	74	51	47.21	52,74
53	90	52,56,74	53	90.61	52,62,74
54	77.36	52,74,88	54	86.92	52,58,74,87
55	61.65	52,56,62,74	55	68.09	44,52,56,58,72,73
60	80.12	37,74,80	60	80.57	74,80
61	65.5	74,80	61	65.5	37,74,80
63	96.68	52,62,74,88			
64	69.8	74,80	64	72.5	38,74
65	76.23	59,74,80	65	87.49	37,38,74
66	74.79	74	66	76.81	37,38,74

Table 6.18: Inefficient hospitals scores and reference sets

Hospital	Efficiency CCR	Reference set	Unit	Efficiency BCC	Reference set
67	60.7	52,56,74	67	65.04	52,56,62,73,74
68	73.22	52,56,74	68	73.82	52,56,58,74
69	93.65	56,74			
71	87.33	52,74	71	90.24	52,56,74
72	92.8	62,74,88			
75	61.04	59,74	75	88.61	44,52,58,73
76	88.19	52,59,74	76	92.86	56,58,74,80
77	73.85	74	77	74.69	56,74
79	98.8	52,56,59,74			
81	83.38	52,74	81	91.01	52,56,62,73,74,89
82	68.82	52,56,74	82	69.03	52,56,74
83	87.63	59,74,80	83	88.31	38,52,74,80
84	48.05	52,74	84	52.01	52,56,58,74
85	66.07	59,74,80	85	69.34	58,59,74
87	84.49	52,74			
89	85.5	56			

Table 6.18 continued: Inefficient hospitals scores and reference sets - Refer to appendix A for hospitals names.

The literature also suggests that general exemplars of good practice are those efficient hospitals appearing most often in the reference sets; and hence best comparison would be with the most often referenced hospitals (Norman and Stoker 1991; and Frontier Analyst Manual). Table 6.19 shows how many times the efficient hospitals have been part of the reference set of an inefficient hospital under the CCR and BCC models.

	CCR			BCC	
Hospital	Score	# Times Referenced	Hospital	Score	# Times Referenced
37	100	1	37	100	9
38	100	0	38	100	13
39	100	1	39	100	0
52	100	38	52	100	36
56	100	14	56	100	28
58	100	2	58	100	18
59	100	19	59	100	6
62	100	6	62	100	5
73	100	1	73	100	8
74	100	59	74	100	42
78	100	0	78	100	0
80	100	15	80	100	5
88	100	6	88	100	2
			1	100	0
			3	100	0
			14	100	0
			40	100	1
			44	100	6
			63	100	1
			69	100	2
			72	100	3
			79	100	0
			87	100	3
			89	100	2

- **Refer to appendix A for hospitals by names**

Table 6.19: efficient hospitals and number of times they have been in a reference set

One insightful use of the reference sets is suggested by Norman and Stoker (1991) who classified units according to their efficiency into four groups, as follows:

1. The robustly efficient units, which are efficient units that are frequently referenced by others.
2. The marginally efficient units, which are efficient units appearing in one or two reference sets.
3. The marginally inefficient units, which have efficiency scores above 90% but less than 100%.
4. The distinctly inefficient units with efficiency score less than 90 %. This group would have difficulty in making themselves efficient in the short

term.

Adopting this classification, table 6.20 classifies the hospitals in this study according to the CCR and BCC models. 7 hospitals are classified as robustly efficient under CCR compared with 11 under BCC. Hospital 88 with 74 beds is the only hospital that robustly efficient under CCR but not under its own scale size. On the other hand hospitals 6,8,12 and 36 are marginally inefficient (scoring above .9 but below 1) under both CCR and their own scale size.

Group	CCR	BCC
Robustly Efficient	52,56,59,62,74,80,88	37,38,44,52,56,58,59, 62,73,74,80
Marginally Efficient	37,38,39,58,73,78	1,3,14,39,40,63,69,72, 78,79,87,88,89
Marginally Inefficient	6,8,12,36,40,44,53,63, 69,72,79	6,8,12,36,50,53,71,76, 81,
Distinctly Inefficient	51 Hospitals	42 Hospitals

Table 6.20: Classification of the hospitals according to their efficiency scores

Robust efficient hospitals can be held up as exemplars of good operational practice. In contrast, distinctively inefficient hospitals are clearly, to a great extent, not managing their resources efficiently and therefore need a closer attention concerning potential improvements. On the other hand marginally efficient hospitals are likely to be peculiar in their operation, where they have gained efficiency because of an unusual mix of services, or some other abnormality in their data. This group deserves a closer look to investigate whether there are any certain characteristics that make them different from other hospitals. The marginally inefficient hospitals are only few points from the efficiency frontier, and may become efficient under a different set of data.

Another of the advantages of DEA, as mentioned in section 6.2.1 is to provide information not only on how efficient a unit is, but also on how inputs and outputs should be adjusted in order to transform inefficient units into efficient ones. Potential improvement information produced by the DEA software package indicates how much and in what areas an inefficient unit needs to improve in order to be efficient. The inefficiencies measured by the "slack" variables are associated with a shortage of output and / or an excessive use of resource inputs. This information can be used as a target to guide an inefficient unit to improve its performance. Table 6.21 provides such an information for 5 of the least efficient hospitals from one of the regions in Saudi Arabia.

	Hospital	41	42	45	46	47
Inputs	Bed days	-39	-41	-26	-28	-37
	Surgeons	-54	-56	-34	-46	-38
	Non Surgical MDs	-58	-68	-60	-68	-60
	Nurses	-34	-58	-51	-43	-56
	NMSTF	-61	-80	-74	-61	-75
Outputs	Discharges	53	34	-19	-12	19
	Inpatient days	-9	-7	-3	6	7
	OPEM visits	-10	-7	131	90	4
	Surgery type	-11	15	8	-9	-2
	Surgery major	33	133	-3	-12	14
	Surgery minor	279	-7	632	431	18

Table 6.21: Potential improvements to achieve BCC efficiency

For example hospital 41, which has a BCC efficiency score of 53.52 %, could achieve efficiency reducing its size by 39%, reducing its numbers of surgeons, non-surgical MDs and nurses by over 50%, and reducing the non-medical staff by 61%. However rather less helpfully, the DEA algorithm implies that these savings in inputs should be accompanied by increases in discharges, major surgery and minor surgery (of 53%, 33% and 279%) and decreases in patient days, open visits and number of surgical specialties (of about 10%). Similar guidance of other hospitals is summarized in appendix B.

6.5 Hospital Characteristics and Efficiency

Having determined the DEA efficiency scores for the 75 MOH hospitals, an important question for this research is to examine the effect of type of management (Contract against Traditional Management) on hospital efficiency. However two other hospital characteristics of obvious importance both conceptually and in terms of possible policy decisions need to be examined. They are hospital size and geographical location.

6.5.1 Three-way Analysis

To investigate the relationships between the technical efficiency derived from DEA and hospital characteristics (type of management, size and regional location), a multivariate analysis is used in which the technical efficiency is the dependent variable and the hospital type of management, size and regional location are the independent variables. In the absence of suitable non-parametric tests a three-way ANOVA has been used to provide an approximate test for interactions between the three factors.

The results of fitting a full three-way ANOVA model are shown in tables 6.22a and b. For both the CCR and BCC efficiency scores, none of the interaction effect are significant.

Source	Type II Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10150.806	21	483.372	2.309	0.007
Intercept	449130.545	1	449130.545	2145.487	0.000
Type of Management	934.793	2	467.396	2.233	0.117
Bed Category	1979.213	1	1979.213	9.455	0.003
Region Category	2511.695	4	627.924	3.000	0.026
TYPMGMT * BEDCAT	235.390	2	117.695	0.562	0.573
TYPMGMT * REGONCAT	1605.047	6	267.508	1.278	0.283
BEDCAT * REGONCAT	1009.558	4	252.390	1.206	0.319
TYPMGMT * BEDCAT * REGONCAT	263.335	2	131.668	0.629	0.537
Error	11094.879	53	209.337		
Total	470376.231	75			
Corrected Total	21245.686	74			

a R Squared = .478 (Adjusted R Squared = .271)

Table 6.22a: Three way analysis

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8383.498	21	399.214	1.887	0.032
Intercept	509472.636	1	509472.636	2408.803	0.000
TYPMGMT	1177.900	2	588.950	2.785	0.071
BEDCAT	219.898	1	219.898	1.040	0.313
REGONCAT	1869.375	4	467.344	2.210	0.080
TYPMGMT * BEDCAT	612.941	2	306.471	1.449	0.244
TYPMGMT * REGONCAT	1960.138	6	326.690	1.545	0.182
BEDCAT * REGONCAT	1354.972	4	338.743	1.602	0.188
TYPMGMT * BEDCAT * REGONCAT	98.493	2	49.247	0.233	0.793
Error	11209.739	53	211.505		
Total	529065.873	75			
Corrected Total	19593.237	74			

a R Squared = .428 (Adjusted R Squared = .201)

Table 6.22b: Three way analysis

Removing insignificant factors individually until only significant factors remain given the results in tables 6.23 a and b. Here it can be seen that for the CCR scores size (BEDCAT) and REGION (REGONCAT) are significant at the 5% level, and type of management is almost significant. For the BCC scores type of management is significant at the 5% level, region is almost significant, but hospital size is not.

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	7511.439	7	1073.063	5.235	.000
Intercept	449130.545	1	449130.545	2191.001	.000
TYPMGMT	1092.499	2	546.249	2.665	.077
BEDCAT	2107.042	1	2107.042	10.279	.002
REGONCAT	2647.924	4	661.981	3.229	.017
Error	13734.246	67	204.989		
Total	470376.231	75			
Corrected Total	21245.686	74			

a R Squared = .354 (Adjusted R Squared = .286)

Table 6.23 a: Three way main effect

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4684.300	6	780.717	3.561	.004
Intercept	509472.636	1	509472.636	2323.716	.000
TYPMGMT	2077.774	2	1038.887	4.738	.012
REGONCAT	2011.146	4	502.787	2.293	.068
Error	14908.937	68	219.249		
Total	529065.873	75			
Corrected Total	19593.237	74			

a R Squared = .239 (Adjusted R Squared = .172)

Table 6.23 b: Three way main effect

Analyses thus far suggest that hospital efficiency is significantly related to type of management, hospital size and regional location. However, no interaction between the three factors has been found. The relationship of efficiency with each factor individually is therefore investigated further next, making use of more appropriate non-parametric statistical tests.

6.5.2 Contract Management and Efficiency

A number of studies have used the DEA efficiency scores to address broader questions such as the effect of ownership on efficiency (Grosskopf and Valdmanis 1987, 1993; Morey, Fine and Lorey 1990; Ozcan and Luke 1993; Ozcan, Luke and Haksever1993; Register and Brunning1987; Valdmanis1990; White and Ozcan1996). However no studies were found that addressed the issue of contract management directly. Public and private ownership could conceptually resemble the difference between contract and traditional management. The general conclusion is that public rather than private hospitals are more efficient (Hollingsworth, Dawson and Maniadakis 1999). Grosskopf and Valdmanis (1987) also found that public hospitals appear to use relatively fewer resources compared to not-for-profit hospitals.

Register and Bruning (1987) found no significant difference in relative technical efficiency between for-profit and non-profit hospitals. However their study only used inpatient days as an output. Had the efficiency scores been computed using a wider set of outputs, a different result may have been produced. Furthermore, Burgess and Wilson (1996) found Veteran Administration hospitals to be most efficient followed by for -profit, non- profit and non-federal hospitals. However, in a later study Burgess and Wilson (1998) found no evidence that differences in ownership structure affect technical efficiency. Ferrier and Valdmanis (1996) in studying rural hospitals found for-profit hospitals to be more efficient than public or not-for-profit counterparts.

The non-parametric Kruskal Wallis test is used to test for a relationship between type of management and efficiency scores in this research. The specific hypotheses are:

Ho: the three types of management have identical distributions of efficiency scores.

Ha: The distributions for at least two types of management differ in location.

The test results (table 6.24 a &b) show that there is a significant difference in efficiency rankings between types of management under both the CCR and BCC models. Regardless of whether efficiency is measured under constant return to scale (CCR) or variable return to scale (BCC), traditionally managed hospitals appear to be the most efficient, followed by comprehensive contract managed, then full service contract managed hospitals.

	TYPE OF MANAGEMENT	N	Mean Rank
CCR	1	7	17.14
	2	34	35.59
	3	34	44.71
	Total	75	
BCC	1	7	16.57
	2	34	35.43
	3	34	44.99
	Total	75	

Table 6.24a: Kruskal Wallis test by teype of management

	CCR	BCC
Chi-Square	10.098	11.097
df	2.00	2.00
Asymp. Sig.	0.006	0.004

Table 6.24b: Kruskal Wallis test by type of management

The boxplot in figure 6.8 clarify the nature of the effects of type of management on both CCR and BCC efficiency scores. There is very little overlap of the efficiency scores of the full service contract managed hospitals and those of the other two types of management. There is a much bigger overlap between comprehensive contract and traditional management, although the latter tends to score more highly for both CCR nad BCC model.

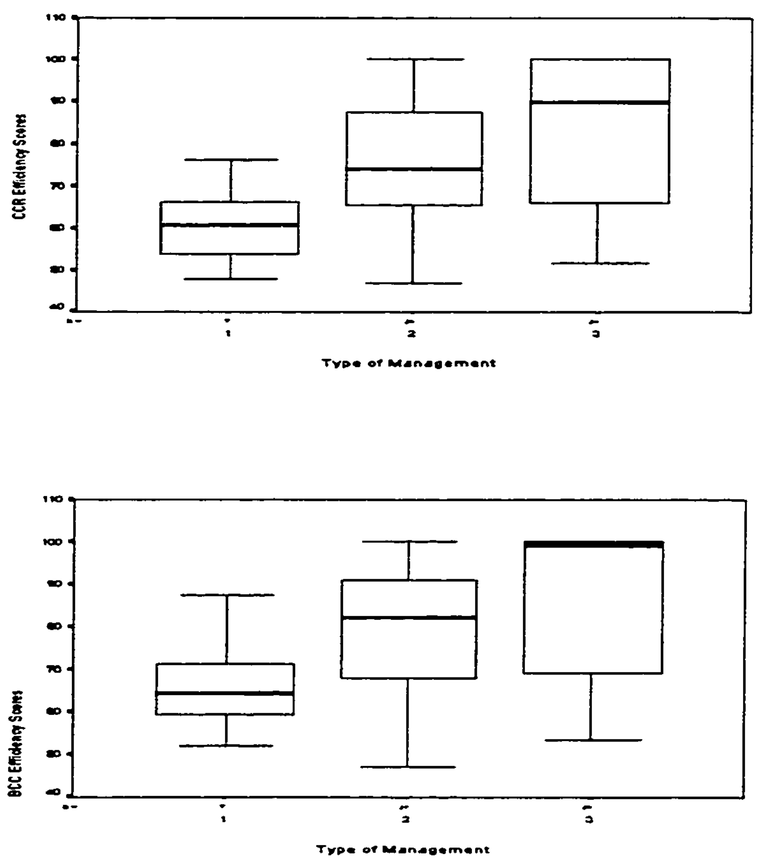

Figure 6.8: Boxplot of distribution of efficiency scores by type of management

Table 6.25 summarizes the mean efficiency scores of hospitals under the three types of management, and can be used to highlight potential efficiency gains. For example, on average, inefficient hospitals under BCC model could have produced the same level of output using (1- 0.664) 33.6 % less inputs in the full service contract managed (type 1) hospitals, (1- 0.801) 19.11 % in the comprehensive contract managed (type 2) hospitals and (1- 0.8725) 12.75 % in the traditionally managed (type 3) hospitals.

Type of Management		CCR	BCC	Scale Efficiency
	N	7	7	7
1	Mean	60.81	66.39	.92
	Efficient	0	0	
	N	34	34	34
2	Mean	75.53	80.89	.935
	Efficient	3	7	
	N	34	34	34
3	Mean	82.66	87.25	.947
	Efficient	10	17	

Type of Management
1-Full service contract

2-Comprehensive contract managed

3-Traditionally managed

Table 6.25: Efficiency results by Type of Management

However under CCR the same level of output could have been produced using (1- 0.6081) 39.2%, (1 - 0.755) 24.5 % and (1 – 0.827) 17.3% less inputs for type1, type2 and type3 respectively. The result also suggests that type 3 is on average (0.8725/0.6639 – 1) 31.5% and (0.8725/0.8089 – 1) 7.9% technically more efficient than type 1 and type2 respectively under the variable return to scale, while it is (0.8266/0.6081 – 1) 35.9 % and (0.8266/0.7553 – 1) 9.4 % more technically efficient than types 1and 2 under the constant return to scale. The minor differences in scale efficiency between the three types of managed hospitals are not statistically significant.

Whilst difference in efficiency between types of management is an important finding for this research, an important question is whether the difference in relative efficiency is achieved at the expense of quality. To answer this question an analysis of the relationship between efficiency and quality needs to be conducted, such an analysis is undertaken in chapter 7.

6.5.3 Hospital Size and Efficiency

Hospital size is an important control variable when examining technical efficiency (Ozcan et al 1992). The results of some previous studies suggest that hospital size is related positively to efficiency (Ozcan and Luke, 1993; Perez, 1992 and Register and Bruning, 1987). However the opposite was found in a study of Veterans Administration Medical Centers (Sexton et al 1989), although the authors noted that is only just significant at the level .05.

Under CCR model, with small hospitals are on average more efficient with a mean efficiency score of 83.8% compared with 70.8% for large hospitals. However, when scale size is accounted for (BCC model), the mean efficiency for the small and large hospitals groups were 85.5% and 79.3

Using a Mann - Whitney test (table 6.26 a &b), to test for differences in rankings between the two groups showed that there is significant difference in efficiency rankings between small and large hospitals under the CCR model. However, as expected, under the BCC model no significant difference was found.

Model	Bed Category	N	Mean Rank	Sum of Ranks
CCR	1	38	46.29	1759.00
	2	37	29.49	1091.00
	Total	75		
BCC	1	38	41.75	1586.50
	2	37	34.15	1263.50
	Total	75		

Bed Category:
1-Small Hospitals
2-Large Hospitals

Table 6.26 a: Mann-Whitney test by hospital size

	CCR	BCC
Mann-Whitney U	388.000	560.500
Z	-3.347	-1.535
Asymp. Sig. (2-tailed)	.001	.125

Table 6.26 b: Mann-Whitney test by hospital size

Table 6.27 summarized the mean efficiency scores of hospitals under the two size groups. The results suggest that if hospitals compared, in reference to the most productive size scale, 34% of the small hospitals are efficient with an over all average efficiency score of 84%, and only 8% of the large hospitals are efficient with an overall average efficiency score of 71%.

Hospital Size		CCR	BCC
Small	N	38	38
	Mean	84	86
	Efficient	10	13
Large	N	38	38
	Mean	71	79
	Efficient	3	11

Table 6.27 : Efficiency results by hospital size

However when size scale is allowed for 34% and 29% of the small and large hospitals are efficient with overall average efficiencies of 86% and 79%. On the average inefficient small hospitals under CCR model could have produced the same output level using (1- 0.84) 16% less inputs, whereas the large hospitals under the same model could have produced the same level of output with 29% less inputs. When size scale is accounted for, small hospitals have very little difference in the amount of resources that needed to be reduced (i.e. 14% compared with 16% under CCR). On the other hand the large hospitals could have could have saved 21% in the resources needed to produce the same level of output. This show that the change for small hospitals is much less than what it would be for the large hospitals because small the most productive size scale is biased toward the small ones.

For the MOH policy makers this means if hospitals are opt to operate at the most productive size scale on average the large hospitals resources have to be reduced by 29%. This may be a conflicting objective for management to reduce the size of hospital in order to increase efficiency because it will have dramatic effect on the scope of services provided that might unlikely to be accepted by the public. Nevertheless it provides guidance to the future hospital projects.

6.5.4 Regional Location and Efficiency

Regional location is an external factor that may affect hospital performance because of, for example, population structure, availability of services across regions or regional health related problems. Very few studies in the literature considered the relationship of efficiency to regional or geographical location. Perez (1992) found that variations in operating efficiency could be partially explained by service area size and regional location among the Veterans Administration hospitals. Ozcan et al (1992) found some evidence of an interaction between ownership and region in studying the effect of ownership on efficiency.

In this research Kruskal-Wallis test results (table 6.28 a & b), suggest that there is a statistically significant difference on the efficiency score rankings between the five regions. Region 5 has the highest average ranking on both CCR and BCC (i.e. most efficient hospitals), region 4 is in second place on both sets of scores. Region 1,2 and 3 are not significantly different from each other, but are some way behind region 4.

	Region Category	N	Mean Rank
CCR	1	18	31.83
	2	19	31.53
	3	6	33.83
	4	23	42.52
	5	9	55.22
	Total	75	
BCC	1	18	34.78
	2	19	29.74
	3	6	33.25
	4	23	41.09
	5	9	57.17
	Total	75	

Table 6.28a: Kruskal Wallis Test by region

	CCR	BCC
Chi-Square	10.00	11.20
Df	4	4
Asymp. Sig.	0.04	0.02

Table 6.28b: Kruskal Wallis Test by region

6.6 Summary and Conclusion

The purpose of this chapter was to look for evidence of efficient and inefficient hospitals, and to determine if there were differences among the hospitals in terms of the type of management, size and geographical location relative to technical efficiency and in what way they differ.

DEA has been used as a non-parametric method to measure the technical efficiency of hospitals and other health care services. DEA has several advantages relative to parametric methods such as Ratio Analysis. However DEA also has some limitations, such as the lack of robustness to data errors. Therefore DEA model has been tested for robustness and sensitivity to data errors in terms of inputs and outputs and DMU selections. Weight restrictions have also been applied to remove some of the unrealistic features of unconstrained DEA. The DEA models (CCR and BCC) scores have been analyzed and inefficient hospitals together with potential improvements have been presented.

The DEA.efficiency scores have then been used as part of further analyses to investigate the effect of hospital type of management, size and regional location on hospital efficiency. The results have shown that traditionally managed hospitals on average are more efficient than contract managed hospitals. A result that is consistent with the findings of many DEA studies in the literature where the technical efficiency of public and for-profit hospitals were compared.

On the other hand, small hospitals tend to be more efficient than large hospitals. This result does not conform to the positive effect of scale suggested in much of the literature.

Regional location has a significant effect on efficiency scores with regions 5 and 4 having the highest efficiency levels under both the CCR and BCC.

In the next chapter possible relationships between DEA efficiency scores and hospital performance indicators are investigated.

Chapter Seven: Combining and Applying Statistical and DEA Results

7.1 Introduction

Chapters 5 and 6 have shown how statistical methods and DEA respectively can be used to compare the performance of individual hospitals and groups of hospitals. Both methods have strengths and weaknesses. In this chapter the results from the two approaches are brought together to investigate and demonstrate how they can be used in combination to inform hospital managers and health care policy makers about the determinants of efficiency and the effects of different types of management and of other hospital characteristics.

Whilst DEA compares hospitals' efficiencies, it provides little insight into the major determinants of efficiency. Section 7.2 therefore uses regression to investigate relationships between DEA scores and hospital performance indicators.

Once such a relationship is established, it is used in section 7.3 to predict the efficiency of individual hospitals (without the need to carry out a DEA); and to advise hospitals about areas of performance improvement.

Applications at the MOH level are described in section 7.4. The regression relationship can again be used to identify the scope for efficiency improvements for the three types of hospital management, for the five regions in Saudi Arabia, and for hospitals of different sizes. This latter point is investigated further by contrasting the regression equations for BCC efficiency scores with the regression equation for the CCR scores. There are also policy concerns about possible trade-off between efficiency and quality, and about possible links between organizational structure and efficiency. The results from chapter 5 and 6 are used to address these issues.

7.2 Operating Performance Determinants of Efficiency

DEA efficiency scores are regressed against the operating performance measures to find out which measures are likely to be predictors of hospitals' efficiencies. But before looking at the regression results, the correlations between the efficiency scores and the performance variables were explored. Regression and correlation are terms used interchangeably, however the first is used when the intent of the analysis is to make predictions while the second is used when the intent is to measure the degree of association between the dependent and independent variables (Tabachnick and Fidell 1089).

7.2.1 Simple Correlations

Table 7.1 shows significant correlations between CCR and BCC efficiency scores and the majority of the 22 operating efficiency performance ratios. There are strong positive correlations between DEA efficiency scores and staff productivity in terms of discharges per medical (DISCTMED), nursing (DISC_NR) and non-medical staff (DISNMSTF); and in terms of surgeries per surgeon (SURG_SGN). On the other hand, strong negative correlations exist between DEA efficiency scores and staffing levels measured by staff to bed ratios (TMEDBED; NURS_BED; NMSTFBED).

Bed throughput, indicated by high bed turn over rate (BTOR), high occupancy rate (OCC_R), low bed turn over interval (BTOI) and low average length of stay (ALOS), is also linked to both efficiency scores. Efficiency scores also have negative correlations with diagnostic procedure rates (LAB_DISC; X_PATIET; X_DISC).

	Spearman's	Correlation
Variables	CCR Efficiency	BCC Efficiency
ALOS	-0.491**	-0.373**
OCC_R	0.363**	0.448**
BTOR	0.691**	0.619**
BTOI	-0.638**	-0.644**
OP_DIS	-0.010	-0.039
EM_DIS	0.093	0.038
SURG_TYP	-0.272*	-0.165
MJRSGDIS	-0.352**	-0.257*
MNRSGDIS	0.310**	0.285*
LAB_DISC	-0.566**	-0.520**
TSTLSTAF	-0.043	-0.020
X_PATIET	-0.416**	-0.307**
X_DISC	-0.428**	-0.315**
X_RSTAF	0.325	0.389
TMEDBED	-0.343**	-0.347**
NURS_BED	-0.337**	-0.342**
NURS_MD	.167	.186
NMSTFBED	-0.298**	-0.375**
DISCTMED	0.684**	0.642**
SURG_SGN	0.596**	0.606**
DISC_NR	0.683**	0.624**
DISNMSTF	0.666**	0.690**

Table 7.1: Correlations Coefficients

**** Correlation is significant at the 0.01 level (2-tailed).**

***Correlation is significant at the 0.05 level (2-tailed).**

Individual PIs, which are highly correlated with efficiency scores, could be used to rank hospitals. However each PI only reflects a dimension of performance with respect to a single input and a single output. Hence a hospital may look efficient under one ratio but the opposite under another ratio. Rankings based on individual PIs may be used in some special cases where specific objectives are set (i.e. profit maximization which emphasizes profit or quantity maximization which emphasizes staff productivity). However as in this research not usually the case.

7.2.2 Regressing Efficiency against Operating Performance Ratios

As noted by Rosko (1990), another use of DEA is to construct an index of efficiency that can be used in studies of the determinants of efficiency, where the efficiency scores serve as the dependent variable.

Multiple regression has been chosen as the analytical tool for this part of the study to analyze the relationship between DEA efficiency scores and hospital PIs. Ideally multiple regression requires that explanatory variables (IVs) are independent (Tabachnick and Fidell 1989). In other words high multicollinearity should not exist. However, input and output ratio based PIs naturally have common denominators, which tend to make them highly correlated. To overcome the redundancy problem stemming from the multicollinearity between the IVs, stepwise regression analysis was used.

DEA produces a "bounded distribution" of efficiency scores, as they range between zero and one, with some units clustered at 1. This non-linearity problem has been discussed in the DEA literature by few researchers (Change 1998; Ferrier and Valdmanis 1996; Sexton et al 1989; Rosko et al 1995). They have suggested a number of relatively sophisticated approaches (i.e. Logit; Probit and Tobit transformations, and logistical regression) to fit an appropriate line to the cermoid shaped set of points. However they offer no real evidence of the success or otherwise of these approaches.

In this research a less sophisticated, more transparent method is chosen, on the grounds that it will be more understandable, and hence more likely to be used, by hospital managers or health care policy makers.

The method used to investigate the relationship between DEA efficiency scores and PIs is based on predicting the efficiency scores of all hospitals using a regression equation derived from the inefficient ones. Figure 7.1a graphs the actual efficiency scores against those predicted by the regression functions for all 75 hospitals. As can be seen, there are good levels of agreement between predicted and actual efficiency scores (both CCR and BCC) for the inefficient hospitals (i.e. those with actual scores <1.0). Furthermore almost all the efficient hospitals (actual score = 1.0)are predicted to be efficient (i.e. predicted score > 1.0) or to be close to efficient (i.e. within the regression equation known margin of error). However, the most serious exception is hospital 80 the top left hand point on both figures. This is an excessively small hospital (50 bed) serving an isolated community on a large island in the south west of the country. It is surgically oriented providing 13 out of 19 surgical specialties, but has the lowest major surgical operations per discharge.

Plots of the predicted efficiencies and the residuals (figures 7.2 a and b) appear to conform to the linearity assumption.

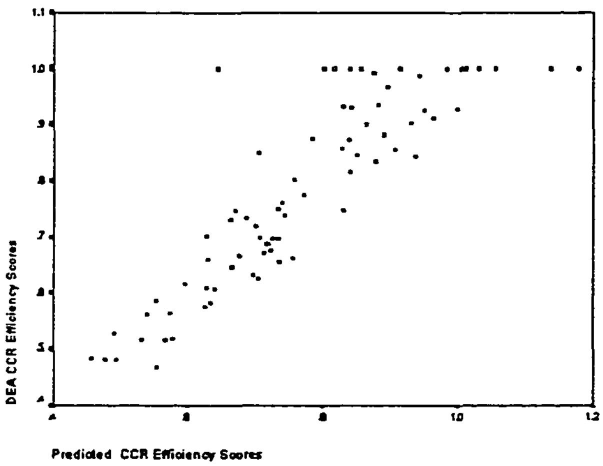

Figure 7.1a: CCR actual and predicted Efficiency Scores

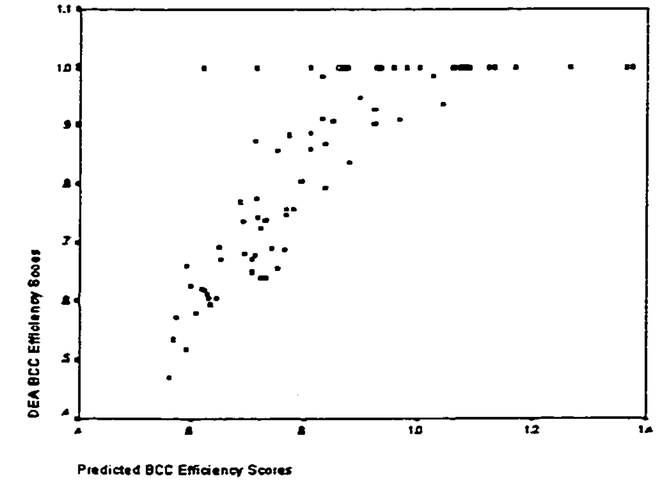

Figure 7.1 b: BCC actual and predicted Efficiency Scores

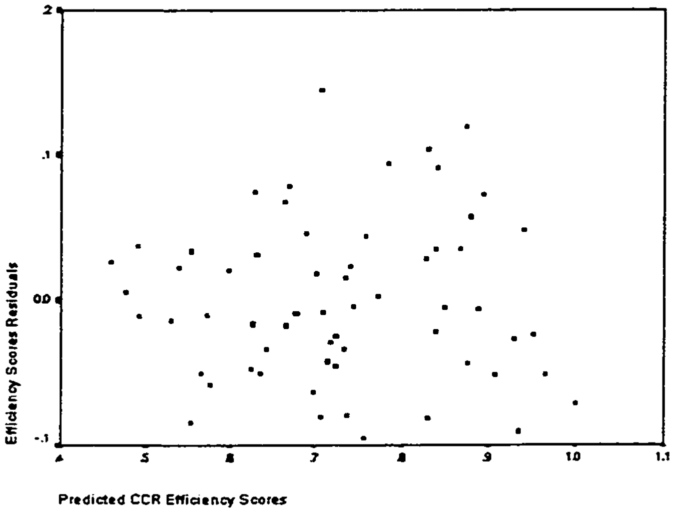

Figure 7.2 a: CCR predicted Efficiency and Residuals

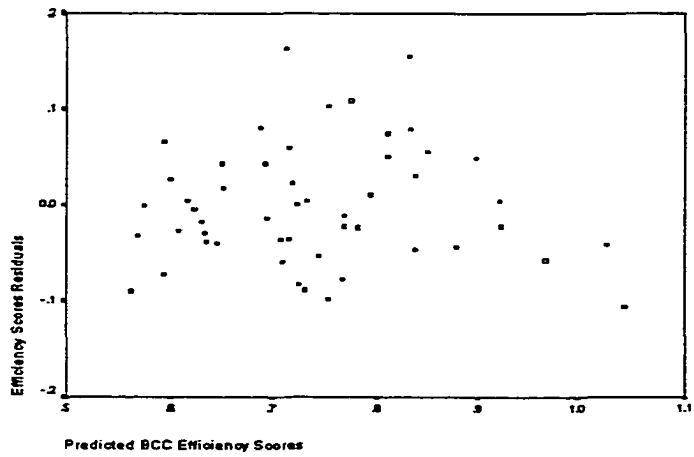

Figure 7.2 b: BCC Predicted Efficiency and Residuals

Stepwise multiple regression analysis revealed that only five operational variables were found to be statistically significant predictors of BCC efficiency scores (see table 7.2 a), with an R squared of .78

	Unstandardized Coefficients	
	Regression Coefficient	**Standard Error**
(Constant)	0.151	0.055**
DISCNMSTF	0.003601	0.001**
OCC_R	0.004276	.001**
SURG_SGN	0.0004332	0.000**
DISC_NR	0.002031	.000**
X_RSTAF	0.00001192	0.000*

Table 7.2 a: Regression Analysis Results

Dependent Variable: DEA (BCC) Efficiency Scores

**** P < .01; * p< .05**

A highly positive significant (p <. 001) relationship was found between relative efficiency and non-medical staff (DISCNMSTF), surgeons (SURG_SGN) and nursing (DISC_NR) productivity, and occupancy rate (OCC_R). In addition a positive but less so significant (p< .05) relationship was found between relative efficiency and radiology staff productivity (X_RSTAF).

	Unstandardized Coefficients	
	Regression Coefficient	**Standard Error**
(Constant)	0.44	0.07**
SURG_SGN	0.0003	0.000**
X-RSTAF	0.00002	0.000**
DISCNMSTF	0.002	0.001**
DISC_NR	0.0015	0.000**
OCC_R	0.00424	0.001**
X-PATIET	-0.07173	0.023*
SURG_TYP	- 0.00877	0.004*
LAB_DISC	- 0.00114	.000*

Table 7.2 b: Regression Analysis Results

Dependent Variable: DEA (CCR) Efficiency Scores

**** P <.01; * p<.05**

In predicting the CCR, eight operational variables were statistically significant predictors of CCR efficiency scores (see table 7.2 b), with an R squared of .86.

A highly positive significant (p <. 001) relationship was found between CCR efficiency scores and surgeons (SURG_SGN), radiology staff (X_RSTAF), non-medical staff (DISCNMSTF) and nursing (DISC_NR) productivity`. Highly positive significant (p <. 001) relationship was also found between CCR relative efficiency and occupancy rate (OCC_R). In contrast a negative but less significant (p< .05) relationship was found between CCR efficiency scores and surgical specialties (SURG_TYP) and lab tests per discharge (LAB_DISC). A negative also but significant at the level .052 relationship was found between efficiency scores and number of x-rays per patient (X-PATIET).

The staff productivity relationship to efficiency finding is consistent with Hao and Pegel (1994), and Huang and McLaughlin (1989) results. However, Hao and Pegel found no significant relationship between occupancy rate and relative efficiency, which is contrary to Rosko et al (1995), Ferrier and Valdmains (1996) and Chang (1998) findings.

Comparing the CCR and BCC regression models (tables 7.2a and 7.2b) revealed that staff productivity and occupancy appear in both, but that the CCR model also includes three significant predictors (SURG_TYP, LAB_DISC and X_PATIET). Theses three indicators are highly correlated with average length of stay and were found to indicate case complexity (refer to chapter 5 table 5.15). The negative coefficients for these three indicators imply that the hospitals that achieve high CCR efficiency tend to have low apparent case complexity.

7.2.3 Efficiency against Performance Ratios Components

DEA measures of relative efficiency are based on simultaneous consideration of multiple inputs and multiple outputs, while each PI measures performance in relation to one input and one output. If several PIs are combined to gain a broader view of the performance of a hospital that view may accord better with that gained by DEA as both views would be based on simultaneous consideration of multiple inputs and multiple outputs (Thanassoulis et al 1996).

In order to gain a broader view of the operating performance of the hospitals, the operating efficiency principal components (**OEFACs)** derived in chapter five were considered to define the sets of combined PIs. These components were then used in stepwise multiple regression as explanatory variables for efficiency scores, as in the previous section. The results were of similar quality. For example figure 7.3 shows the relationship between actual and fitted values for the BCC model.

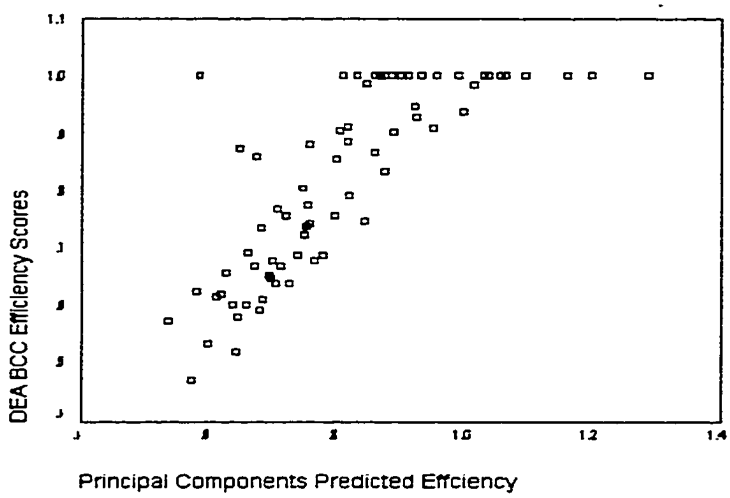

Figure 7.3: BCC actual and PCs predicted Efficiency Scores

Multiple regression results shown in table 7.3 revealed that all the operating components are significant predictors ($p < .01$) of efficiency with an R squared of .69 for BCC and .767 for CCR.

CCR and BCC efficiency scores have similar positive relationships with the bed throughput component (OEFAC2) and have similar negative relationships with staffing level component (OEFAC3). The outpatient throughput component (OEFAC 4) also has similar positive relationships to both cases, suggesting that hospitals with more outpatient services are more efficient. Both scores have a negative coefficient for the case complexity component (OEFAC1), but in this case, case complexity is noticeably more important for the CCR scores than for the BCC. The negative coefficient for case complexity support the hypothesis and finding by Chang (1998) that operating complexity reduces hospital efficiency. However Chang used scope of services, which reflect the supply side of service to reflect operating complexity. In this research the a more patient care related indicators were included in the case complexity component [i.e. ALOS, surgical specialties (SURG_TYP), lab tests per discharge (LAB_DISC), x-ray per discharge (X_DISC) and major surgical operations per discharge (MJRSGDIS)].

	Regression Coefficient		Standard Error	
	BCC	CCR	BCC	CCR
(Constant)	0.8129	.761	0.0133**	0.01**
OEFAC2	0.1197	0.101	0.0133**	0.011**
OEFAC3	-0.0928	-0.0707	0.0142**	0.011**
OEFAC4	0.0468	0.0495	0.0137**	0.011**
OEFAC1	-0.0320	-0.0652	0.0101**	0.009**

Table 7.3: Efficiency and Operating Performance Components Regression

Dependent Variable: DEA (BCC) Efficiency Scores

**** P <.01**

OEFAC1: Case Complexity; OPFAC2: Bed Throughput;

OPFAC3: Staffing Level; OPFC4: Outpatient Throughput.

7.3 Hospital Level Applications

7.3.1 Predicting DEA Efficiency without undertaking a DEA

Having found that the regression models described in the previous section provide reasonable predictions of efficiency scores, the MOH could use them to estimate hospital efficiency score without the need to do a DEA.

The ease of simply substituting performance ratios into a regression equation, and the transparency of the results has clear advantages over carrying out and interpreting a DEA. However the validity of the equations would also need to be checked from time to time against further DEA results.

7.3.2 Advising Hospital Managers about Performance Improvements

In this section the regression model is used to advise hospital managers about the scope for performance improvements at their hospitals.

Whilst at a strategic level there will be considerable interest in understanding the effect of hospital size, at a hospital level interest will mainly be in increasing efficiency given size. Hence the regression coefficients for the BCC model, see table 7.2 a, indicates that the major variables explaining efficiency are related to staff productivity and bed throughput. Increases in the productivity of non-medical staff, surgeons, nurses and radiology staff will all increase estimated efficiency scores. An increase in occupancy rate would also lead to an increase in estimated efficiency. Obviously a hospital might try to increase its occupancy, simply by increasing length of stay. However this would probably require more nursing staff, and hence decrease nurse productivity.

The regression coefficients indicate the separate impact of each predicting variable. For example + 0.004276 indicates the expected amount of increase in efficiency if occupancy rate increased by one unit and all other variables are held constant. These coefficients can be used to advise hospital managers about the magnitude of change in efficiency caused by a change in any of the predictors. This exercise will help in identifying the important PIs that should be the focus of the hospital managers in improving efficiency. For example table 7.4 shows amount of expected change in efficiency for an average hospital by changing each predictor individually and holding the other predictors constant.

	Amount of change in efficiency*
Reducing the number of NMSTF by 10%	0.0144
Increasing occupancy rate by 10 %	0.029
Reducing the number of surgeons by 10 %	0.0111
Reducing the number of Nurses by 10%	0.0145
Reducing the radiology staff by 10%	0.0027

Table 7.4: Changes in BCC Efficiency by changes in predicting Ivs

*** Calculations are based on an average values of the IVs**

For example, if non-medical staff are reduced by 10% there will be an increase in non-medical staff productivity by 11% (1/(1- 0.1)). For an average hospital with a non- medical staff productivity (DISCNMSTF) of 36.25, the efficiency contribution is (36.25* 0.003601= 0.1305). After the 10% reduction the new contribution will be ((36.25 *1.11)*0.003601 = 0.1449). Hence the increase in efficiency if the non-medical staff is reduced by 10% will be (0.1449 - 0.1305 = 0.0144). The effects of 10% reductions in the other staff groups are calculated in the same way.

The calculation for occupancy rate is little different. An average hospital has 67.7% occupancy rate, which contribute (67.76 * 0.004276) 0.2897 to its efficiency score. If occupancy increases by 10% it will be (67.76 *1.1=74.54), the contribution to the efficiency will be (74.54 *0.004276) 0.3187, and hence the resulting change in efficiency is (0.3187 - 0.2897) 0.029.

When average values were used in table 7.4, a 10% change in occupancy rate had the highest effect on efficiency. However applying the actual numbers for each hospital may yield different results depending on the values of the predicting variables. Also a hospital already doing well in one indicator may be seen as having more impact from altering that indicator, but might have no potential for a change because the hospital is already achieving a high level on the indicator. For example, as shown in figure 7.4 there are quite a number of hospitals already operating at a high occupancy (80% - 100%) therefore occupancy rate should not be their focus for efficiency improvement. Whereas the hospitals operating at less than 65% might be able to increase occupancy by at least 23 % to reach an occupancy level of 80%. The same principal applies to the other predicting indicators.

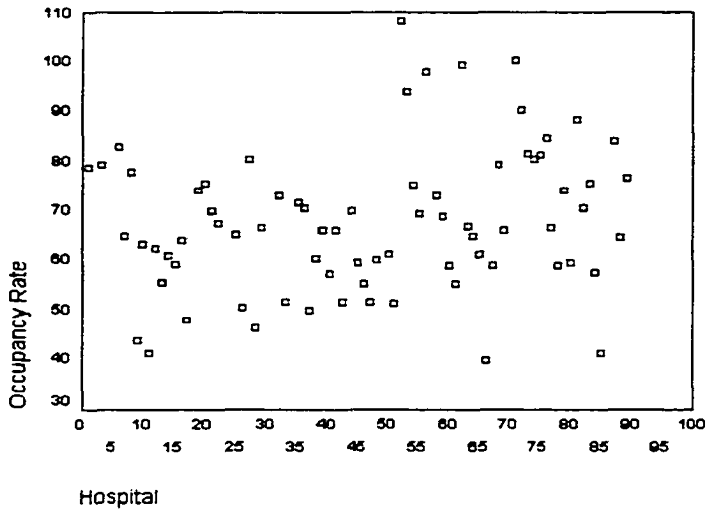

Figure 7.4 Hospital and Occupancy Levels

7.4 MOH Level Applications

MOH policy makers and health planners are not involved in the day to day operations of the hospitals nor are they directly concerned with them. However type of management, regional location and hospital size are major concerns for the MOH policy makers and health planners.

7.4.1 Scope for Efficiency Improvements: Type of Management

In chapter six it was found that traditionally managed hospitals are on average more efficient than contract managed hospitals, and hence the MOH is bound to be concerned with how performance could be improved under each type of management. The following example shows how the model presented earlier can be used in identifying areas where there is a scope for improvement for each type of management.

The predicted efficiency improvements for a 10% change in PIs are calculated, as in section 7.3.2, for each type of management (table 7.5). The results again give an indication of the impact on efficiency of changes in the five PIs.

	Amount of change in efficiency*		
Variable change	**Full Service Contract Managed**	**Comprehensive Contract Managed**	**Traditionally Managed Hospitals**
Reducing the number of NMSTF by 10%	0.0079	0.0118	0.0183
Increasing occupancy rate by 10 %	0.0273	0.0304	0.0279
Reducing the number of surgeons by 10 %	0.0081	0.0092	0.0136
Reducing the number of Nurses by 10%	0.0094	0.0144	0.0157
Reducing the radiology staff by 10%	0.0018	0.0026	0.003

Table 7.5: Changes in type of management BCC efficiency scores by changes in predicting variables

***Calculations are based on average values of the IVs**

However the three types of management differ in how well they score on these predicting indicators, see table 5.3, and hence the potential for efficiency improvements differs between them. For instance full service contract managed hospitals are lowest in non-medical staff productivity and therefore have greatest potential for efficiency improvement in that area. In the same sense, nursing staff is another area for potential efficiency improvement in full service contract managed hospitals.

7.4.2 Scope for Efficiency Improvements: Regional Location

At the MOH level they are also concerned about how well all five regions are performing and what, if any, are the performance problems faced by the regions. DEA via the regression equation can help the MOH policy makers in identifying potential areas for performance improvements at the regional level. The results in table 7.6 indicate the impact of 10% changes in the five PIs on efficiency, based on the average values for each region. For example it was seen in section 5.1.3 that region three tended to be the lowest region in non-medical staff productivity and lowest in nursing staff productivity. Hence 10% changes in these low productivity levels lead to the smallest contributions to efficiency scores shown in table 7.6. However, because region three has the lowest productivity levels, it may well be possible to increase it by more than 10%. Hence potential efficiency gains need to be estimated by combining the contributions in table 7.6 with information on the scope for productivity improvements.

	Regions				
Variable Change	**1**	**2**	**3**	**4**	**5**
Reducing the number of NMSTF by 10%	0.0137	0.01218	0.01184	0.01486	0.02178
Increasing occupancy rate by 10 %	0.0267	0.02723	0.0321	0.02927	0.03435
Reducing the number of surgeons by 10 %	0.0118	0.00885	0.01279	0.01057	0.015185
Reducing the number of Nurses by 10%	0.0124	0.01336	0.01071	0.01662	0.019244
Reducing the radiology staff by 10%	0.00314	0.00193	0.00267	0.00309	0.00261

Table 7.6: Changes in regions BCC efficiency scores by changes in predicting variables

*** Calculations are based on average values of the IVs**

The potential improvements identified in this process will help MOH in reallocating its resources on the regional level for better utilization and contribute positively to equal provision of health care services to all citizens.

7.4.3 Scope for Efficiency Improvements: Hospital Size

Part of the main tasks of MOH policy makers and health services planners is health programs and facilities planning at a broader level including allocation of facilities and the size scale of their services. Hence the optimum operating scale of operation is important at this level.

CCR efficiency, as explained in chapter six, measures the efficiency relative to the optimal scale of production, which was found to be the small size scale. In section 7.2.2 it was found that hospitals with low case complexity would achieve higher CCR efficiency. However large hospitals tend to score more highly on indicators of case complexity. It can therefore be argued that it is unreasonable to expect all large hospitals to achieve the efficiency levels of the smaller hospitals if some of them are tackling more complex case mix. Therefore the focus of the MOH should be on the large hospitals with low case complexity mixes, for optimum operating scale efficiency improvements.

7.4.4 Relationship between Efficiency and Quality

Quality is expected to correlate negatively with efficiency because improving quality would be likely to require greater efforts and resources, and hence a higher quality care requires an input mix that may differ from the efficient mix (Ferrier and Valdmanis 1996). From that perspective policy makers often assume a trade-off between efficiency and quality of care (Rosko et al 1995). With the level of constraints on the MOH resources, as discussed in chapter 1, the question of whether or not trade-offs exist between efficiency and quality of care becomes particularly important.

Kendall's tau-b, a non-parametric measure of association for ordinal or ranked variables that take ties into account, was used to test the relationship between the DEA efficiency and case mix adjusted death rates. The Kendall tau- b coefficients (-0.279 for CCR and - 0.268 for BCC) indicate no evidence of a trade-off, indeed they provide significant evidence ($p < .01$), though small, of the opposite. However, although these correlations do provide some evidence about trade-offs between efficiency and quality, the nature of the correlations may only be true at the extremes. For example figure 7.5 shows the negative correlation between efficiency and case mix adjusted death rate to be almost wholly due to four inefficient hospitals that have the four highest adjusted death rates.

Similar test also showed significant negative correlations (- 0.273 for CCR and - 0.25 for BCC), i.e. a trade-off between efficiency and medical staff qualifications (a structural indicator of quality of care).

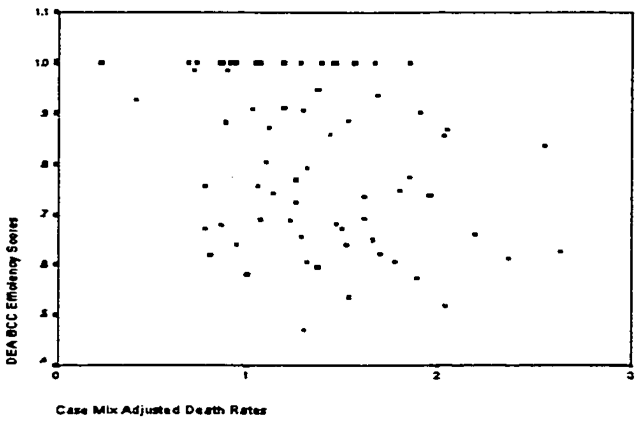

Figure 7.5: Efficiency and Death Rate

7.4.5 Relationship between Efficiency and Organizational Structure

The relationship between organizational structure and performance is another important issue for the MOH in Saudi Arabia. CM is expected to provide a hospital with an infusion of managerial resources, which can increase operating efficiency. Previous studies that looked at this relationship used financial indicators in assessing the performance of hospitals (Biggs et al 1980). However, no study in the literature has been found which addresses the relationship between organizational structure elements and DEA efficiency scores.

Kendall's tau-b results shown in table 7.7 revealed significant negative, although small, correlations between DEA efficiency scores and ORGCH2, ORGCH3, QM1, HIS2, HIS3 and HIS4.

Organizational Variables	CCR	BCC
ORGCH2	- 0.227*	- 0.259**
ORGCH3	- 0.27**	- 0.247**
QM1	- 0.224*	- 0.281**
HIS2	- 0.278**	- 0.241**
HIS3	- 0.27**	- 0.264**
HIS4	- 0.237**	- 0.233**

Table 7.7: DEA and organizational Variables correlations

These results suggest that efficiency is achieved with less organized structure in terms of the clearance of lines of authority (ORGCH2), clearance of responsibilities (ORGCH3), organized quality management activities (QM1) and the availability of hospital information systems (HIS2, HIS3 and HIS4). As these elements are part of the contract management scope of work as specified by the MOH, this result, which is consistent with the findings in chapter 5, suggests that better organizational structure may have contributed to the inefficiency of contract managed hospitals.

7.5 Summary and Conclusions

This chapter brings together the results of the statistical analysis (chapter 5) and DEA (chapter 6) and shows how the two can be used in combination to address the main issues of this research.

Defining the significant determinants of efficiency from the operating efficiency components will provide hospital managers and health services policy makers an insight into the PIs on which they should focus attention to improve their hospitals' efficiencies. The results suggest a strong positive relationship between DEA efficiency and staff productivity and occupancy. If size factors are ignored results also suggest that case complexity has a negative impact on CCR efficiency.

It has been shown through a number of examples of how hospital managers can use the model to improve efficiency utilizing readily available performance indicators. It has also been shown how MOH policy makers and health services planners can use the model in dealing with health care issues of particular concern (i.e. contract management, facilities planning and optimum scale size).

The issue of possible trade-offs between efficiency and quality of care has been discussed. No evidence of trade-off was found between efficiency and case mix adjusted death rate. However, the relationships between efficiency and structure measures of quality did suggest a trade-off. However both sets of results are rather weak.

Findings also suggest that inefficient hospitals have better organizational structure, which requires more resources that may have contributed to the inefficiency.

The overall findings in this chapter have shed light on the determinants of efficiency. The results provide practical guidance for and help to identify efficiency problems in terms of traditional PIs that are normally available in the hospitals.

At a methodological level this chapter has demonstrated how DEA and traditional statistics methods can be, and perhaps should be, used together in studies designed to inform hospital managers and health care policy makers about determinants of efficiency and possible routes to improved performance.

Chapter Eight: Summary and Conclusions

This chapter provides a summary of the research framework (section 8.1); highlights the main empirical findings (section 8.2); and discusses their implications for health care management and policy making in Saudi Arabia, and more broadly for health services research (section 8.3).

8.1 Research Framework

This research has been concerned with enhancing the understanding of contract management and performance in Saudi Arabian hospitals, through providing greater insights into the relationship between the forms of hospital management and hospital performance.

Chapter one presented a general overview of the Saudi Arabian health system with particular emphasis on the MOH. It also, presented and discussed the purpose of the research. The primary purpose of this study has been to evaluate the performance of the Saudi Arabian Ministry of Health hospitals under the three types of management (full service contracts, comprehensive contracts and traditional) applied by the Ministry to manage and operate its hospitals. A second major purpose has been to help explain the differences in hospital performance and explore the impact of the types of management and other hospital characteristics likely to effect performance, e.g. bed size and demographic issues.

A number of important issues have been addressed within the context of this research. First, a general framework for performance evaluation and the more specific issue of analyzing hospital contract management were required. The existence of diverse perspectives on hospital performance measurement and evaluation provided an important challenge for this study. A second concern is the specific issue of how hospital performance is effected by type of management.

Chapter 2 more specifically discussed hospital performance, its different perspectives and measures. The Goal attainment perspective was selected, because hospitals main common goals concern patient care, whereas the alternative system maintenance and open system perspectives may differ between hospitals according to their internal organizational needs and the differences in their environments.

The fundamental goal that is commonly shared by all hospitals and that distinguishes hospitals from other types of formal organizations is the provision of medical services aimed at cure, amelioration and prevention disease in individuals.

From the varied and diverse dimensions of performance that have been identified in the literature, an inter-organizational operating goals perspective, i.e. effectiveness and efficiency, has been selected as the main focus of this research. This research has focussed on the quality of care aspect of hospital effectiveness, using available data.

In addition, several organizational structure variables related to hospital performance have been identified and included as indirect indicators of performance.

Chapter three defined and discussed the concept of contract management. Whilst the main concern of this research is contract management (CM) in Saudi Arabian hospitals, most research into CM has been undertaken elsewhere. The CM literature has been reviewed to provide an overview of hospital contract management perspectives in two different health care industries (USA and UK); discuss hospital

CM motives, policies, structures and processes; identify research issues and methods relevant for the MOH in Saudi Arabia.

In general, while the Saudi Arabian health care system has a great similarity in terms of structure to the UK National Health Service, the motives of the Saudi MOH to use contract management has much in common in general terms with motives identified in several US-based studies (i.e. to overcome the professional manpower recruitment, financial and administrative problems). The research literature implies that CM has a positive impact on hospitals` operational efficiency, including improvements in profitability and increases in efficient use of fixed assets following the adoption of contract management. However very few studies looked at the impact of CM on quality of care and organization. Moreover, much of the CM research is based on small sample sizes, often of small hospitals.

Much of the literature also fail to account for other hospital characteristics (e.g. size and regional location), and for differences in types and terms of management contracts (i.e. full service, departmental) is another shortcoming of much of the literature. Nevertheless, the literature provided a general conceptual framework for the empirical aspects of this research.

Chapter 4 more specifically defined the study design and methodology used to perform the empirical investigations. The fundamental question that the research seeks to answer is " how does the performance of contract managed and traditionally managed MOH hospitals differ?". However, the study goes beyond a comparison of the two groups to examine the underlying differences between hospitals and the extent to which they are associated with, or perhaps attributable to, type of management.

The research methodology is essentially a cross-sectional analysis of performance of 75 MOH hospitals to examine the impact of type of management on the selected dimensions of hospital performance: efficiency, quality of care and organizational structure. Initial questions concerned whether or not contract management was performing better than traditional management, and led to three provisional null hypotheses to be tested.

Hypothesis 1: Operating efficiency does not differ significantly by type of management.

Hypothesis 2: Quality of Care does not differ significantly by type of management.

Hypothesis 3: Organizational structure elements (that have an impact on hospital performance) do not differ significantly by type of management.

However in multivariate situations such as this it is rarely possible to test such simple hypotheses directly. There will always be confounding variables (e.g. hospital size, region). Whilst in theory these can be controlled for, in practice, as was the case here, the amount of available data severely limits this approach. Hence, whilst the study maintained its interest in these specific questions, a more realistic objective was to undertake analyses likely to shed light on these issues.

The research methodology has used a variety of analytic approaches, with the hope that the strengths of one would counteract the weaknesses of another, and vice versa. The results of this empirical work are described in chapter five, six and seven.

In chapter 5, a series of univariate and multivariate statistical methods have been used to investigate the extent to which the three dimensions of hospital performance (efficiency, quality of care and organizational structure) can be explained by the type of hospital management and/or other factors.

As a particular feature of this research is the need to analyze multiple inputs and multiple outputs simultaneously. Data Envelopment Analysis (DEA), has been used in chapter 6 to estimate the relative efficiency scores of the hospitals.

Chapter 7 then brought together the results of the statistical analyses and the DEA, and showed how they can be used in combination to address real issues related to CM and hospital performance in Saudi Arabia.

8.2 Summary and Discussion of Major Findings

Following the structure of the thesis, the next three subsections cover the findings from the multivariate statistical analyses, the DEA, and their combination, respectively.

8.2.1 Multivariate Analyses

Ratio analyses, factor analyses and discriminant analyses results suggest that important differences exist between contract management and traditional management when compared along the performance dimensions selected for this study. Thus the provisional hypotheses that the two groups do not differ in their performance have been rejected. The major findings can be summarized as follows:

A. Operating Efficiency

The analyses revealed consistent results on the differences between contract and traditional management. Significant differences were found, after allowing for hospital size and regional location, on staff availability and staff productivity, with traditionally managed hospitals having lower staffing levels and higher staff productivity levels than contract managed hospitals. This relative over staffing and under productivity in contract managed hospitals may be a result of the contract specifications being set to the "full operational" level, which tends to over estimate actual acting and usage levels.

In addition, staffing patterns results show significant differences by type of management. Traditionally managed hospitals tended to have higher proportions of nursing staff, while contract managed hospitals tended to have higher proportions of non-medical staff with 70% being non-technical.

The results also revealed that traditionally managed hospitals were on average providing significantly more services per patient in terms of outpatient visits, x-ray procedures and number of surgeries per discharge. In contrast contract managed hospitals tended to provide larger range of surgical specialties.

B. Quality of Care

The analyses provided no strong evidence about whether traditional management or contract management provided the higher level of quality of care, a situation which can be partly attributed to the lack of more appropriate quality measures. However, in general terms, contract managed hospitals have higher quality related indicators, i.e. higher levels of medical and surgical staff qualifications, wider scope of services and the better nursing staff structures.

C. Organization Structure

Contract management presented a picture of hospital management that differed significantly from traditional management. Contract management is associated with more highly educated administrative staff and more a structured organization.

Overall, when performance ratios were used to predict the type of hospital management, there was a clear distinction between type 1 (full service contracts) and type 3 (traditional management). However neither type was strongly distinguished from type 2 (comprehensive contracts), which captures some of the features from both.

8.2.2 Data Envelopment Analysis

A number of theoretical and practical concerns about the application of DEA have been addressed, which led to the generation and comparison of the results of a range of DEA models. Two sets of DEA efficiency scores were then selected for the hospitals, one of which assesses hospital efficiency relative to the whole group (CCR), and the other assesses it relative to hospitals of similar size (BCC).

The relationships between hospital technical efficiency and type of management and other hospital characteristics (size and regional location) were then examined using ANOVA and appropriate non-parametric tests. These showed that traditionally managed hospitals on average are more efficient (BCC and CCR) than contract managed hospitals, and are consistent with the findings of many DEA studies in the literature in which relative efficiency of public and for profit hospitals were compared. On the other hand small hospitals were found to be more efficient (CCR) than large hospitals, which does not conform to the positive effect of scale suggested in the literature. There were also significant differences in efficiency scores between regions, with region 5 having the highest efficiency under both DEA models (CCR and BCC).

The DEA results also provide efficiency scores for each of the 75 hospitals, together with suggestions for potential improvements for those which are inefficient. For each inefficient hospital the reductions in inputs and / or increases in outputs needed to bring the hospital up to full efficiency are identified.

8.2.3 Implications of Combined Analyses

Chapter seven has brought together the results from chapters five and six to address a number of important hospital management and health care policy issues in

Saudi Arabia. The particular issues addressed are:

- Predicting hospital efficiency without DEA
- Potentials for efficiency improvement by type of management
- Potentials for efficiency improvement by regional location
- Hospital size and efficiency improvement
- Trade-off between efficiency and quality of care
- Relationship between efficiency and organizational structure

In addition to demonstrating the value of the earlier analyses, this chapter also highlights some of the benefits of using statistical methods and DEA in tandem.

8.3 Discussion and Future Work

Any discussion of the implications of this research and ideas for further work need to be in the light of the acknowledged limitations of this work. These are therefore highlighted.

8.3.1 Limitations of this Study

Four important limitations of this work have been identified in this section:

- The purpose of this study was to investigate the relationship between types of management and hospital performance. As such, the cross-sectional design was appropriate. However cross-sectional designs are unable to provide information on trends and changes over time and hence preclude the identification of causal relationships (Kidder and Judd 1986). Hence, throughout the presentation of results and discussion of findings, the emphasis has been on association between type of management and performance, and not on causation.

- An important limitation of many hospital data sets, and those in Saudi Arabia are no exception, is the absence of an adequate measure of case mix and complexity. In this study, average length of stay was used as a proxy for case mix and complexity. However this is far from perfect, and case mix related findings have had to be interpreted with care.
- The DEA efficiency scores were based on two main categories of inputs (capital and labour). A third category that has not been included is supplies expenses because the MOH does not keep records of supplies expenses by hospital. Hence relative efficiencies have been calculated on the basis of capital and labour inputs only. Nevertheless they account for a major portion of the total inputs cost.
- A final limitation relates to the subjectivity involved in interpreting and naming the factors emerging from the factor analysis. Characterizing latent variables based on the factor loadings is always subject to some uncertainty; the only guidelines which exist are rough rules of thumb regarding factor loading cutoffs, along with 'reasonableness' in judging and naming the factors. However the factors obtained were generally consistent with the results obtained elsewhere in the analyses.

8.3.2 Implications

The findings of this study have several implications for MOH hospital management practices in Saudi Arabia as well as implications for health services research in general.

8.3.2.1 Implications for Saudi Arabian MOH

It has been argued that whilst contract management improves a hospital's capabilities to achieve its patient care objectives, it nevertheless often provides a hospital with excess resources that are under utilized. Contract specifications, which set the resources (operating expenses and manpower) to full operation level, need to be reconsidered and a more realistic operational level should be used as a base for setting the contract scope and resource levels. In particular the MOH should link the level of operation to the provision of resources.

DEA efficiency assessment has provided insights on the relative efficiencies of hospitals when compared to similar sized hospitals and to all hospitals. Those with very low efficiency scores have been identified and changes that would make them more efficient are suggested. The MOH need to look at these hospitals more closely, to find out more details about them and to explore any common characteristics that would enhance the efficiency of hospitals in practice.

DEA also provided insights on the most productive scale size. It suggests that small hospitals (=< 150 beds) are the most productive. However, it also provides evidence that some of the larger hospitals deal with more complex cases. Future policies on hospital size should perhaps expect more hospitals to achieve the efficiency levels currently found mainly in small hospitals, whilst recognizing that some larger hospitals will be needed for more complex cases, and that their target efficiency levels might need to be different.

This study provides hospital managers and MOH policy makers with a number of examples, presented in chapter 7, of how to improve and monitor hospitals' efficiencies at both the hospital and regional levels using performance indicators that are readily available. These models can be used to guide performance improvement at individual hospitals, for hospitals in particular regions, and for hospitals with particular types of management.

DEA is quite a sophisticated tool for efficiency assessment, and when it is available requires more significant expertise to use and interpret, beyond what can be expected of many of the hospital managers and health services planners. On the other hand, the MOH can use the regression models to estimate efficiency scores for its hospitals, and utilize this information to guide performance improvement.

8.3.2.2 Implications for Health Services Research

The existence of diverse perspectives on hospital performance measurement and evaluation provided an important challenge for this study. The various perspectives and varied measures make it difficult to develop a sensible framework for assessing hospital performance in broader terms. The framework for performance assessment presented and applied in this study highlights the difficulty of assessing the overall performance of hospitals. The application of the framework on real data and the investigation of the relationships between the performance dimensions provide some guidance for any future research in this area.

The application and combination of different methods of analysis in this research has shown that the strengths of one can be used to help overcome by the of the weaknesses of another. In this study, ratio analyses and DEA have been applied in tandem to improve understanding of efficiency scores and to highlight the performance aspects that are significantly related to efficiency. The results provide practical guidance for policy makers and help hospital managers to identify efficiency problems in terms of traditional PIs that are normally available in the hospitals. These results have shown that DEA and traditional statistics can be, and perhaps should be, used together in any attempts to understand and improve hospital performance.

8.3.3 Suggestions for Future Research

This study has answered a number of important questions concerning the relationships of contract management and other hospital characteristics to hospitals operational performance, at least in Saudi Arabia. However important questions remain to be answered, and further research is suggested in the following areas.

- The proxy nature of ALOS as a measure of case mix was identified as an important limitation in this study. The importance of case mix in assessing hospital performance means that better measures of case mix are required in Saudi Arabian MOH hospitals. This implies identifying, structuring and collecting proper data on which to base a MOH specific case mix index, perhaps utilizing the ICD10 system which is recognized internationally but never been implemented by the MOH.
- Using time series data to examine the impact of different contractors on hospital performance over time may provide valuable insights into the relationship between contract management and hospital performance. One area of focus may be the stability or otherwise of hospitals performance as contractors are introduced or are changed.
- The limited number of quality measures that were available has limited the contribution of this study in exploring the trade-off between efficiency and quality. More measures, in particular those directly related to quality (e.g. readmission rates within 15 days of discharge, rates of hospital born infections, rates of surgical complications, and properly case mix adjusted death rates) would provide a better data set for analyses of efficiency and quality trade-offs.

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APPENDIX A

A.1 - MOH Raw Data Set

A.2 - Hospitals' Names list

A.3.1 - Survey Questionnaire

A.3.2 - Survey Instrument Reliability

A.1 Original MOH Data Set

The data obtained from the MOH, for the 75 hospitals in the study, are listed below. For the analyses, some variables were directly taken from this set, other variables were needed to be calculated.

1.1. Operating Efficiency

- 1.1.1. Total number of Beds
- 1.1.2. Average Length of Stay
- 1.1.3. Occupancy Rate
- 1.1.4. Bed Turnover Rate (number of discharges per bed)
- 1.1.5. Bed Turnover Interval
- 1.1.6. Total number of Admissions
- 1.1.7. Total number of Discharges
- 1.1.8. Total Inpatient days
- 1.1.9. Total number of Outpatient Visits
- 1.1.10. Total Emergency Room Visits
- 1.1.11. Total number of Laboratory Tests
- 1.1.12. Total number of X-ray Films used
- 1.1.13. Total number of Xray Episodes
- 1.1.14. Number of Radiologists
- 1.1.15. Number of Radiology Technicians
- 1.1.16. Total number Surgical Operations
- 1.1.17. Number of Surgical Operations by Surgical Specialty [19 Specialties e.g. General (minor and major), Ophthalmology (minor and major), ENT (minor and major), Orthopedics Operation, Orthopedic Gypsum, Urology/ Nephrology, Other Urology, Cardiac, Other chest Surgeries, Caesarean, Other OBGYN, Plastic, Dental, Maxiofacial and pediatric)
- 1.1.18. Total number of Physicians (Residents, Specialists and Consultants)
- 1.1.19. Specialist
  - 1.1.19.1. Total number of Nurses (Registered, Staff)
  - 1.1.19.2. Midwives
  - 1.1.19.3. Pharmacists
  - 1.1.19.4. Medical Specialists (pathology, radiology, OR,...)
  - 1.1.19.5. Medical Records
  - 1.1.19.6. Statistics
- 1.1.20. Technicians
  - 1.1.20.1. Pathology, Radiology, OR, ...)
  - 1.1.20.2. Medical Records
- 1.1.21. Non-medical Technicians and non technicians
  - 1.1.21.1. Engineers
  - 1.1.21.2. Administrative Staff

1.1.21.3. Mechanics and craftsmen
1.1.21.4. House Keeping Staff

1.2. Quality of Care

1.2.1. Maternity
- 1.2.1.1. Total number of Normal Born Alive Babies
- 1.2.1.2. Total number of Normal born Dead Babies
- 1.2.1.3. Total number of Normal Born Dead after Delivery
- 1.2.1.4. Total Premature Born Alive Babies
- 1.2.1.5. Total Premature Born Dead
- 1.2.1.6. Total Premature Dead During Labor Babies
- 1.2.1.7. Total Caesarean Born Alive
- 1.2.1.8. Total Caesarean Born Dead
- 1.2.1.9. Total Caesarean Born Dead during procedure
- 1.2.1.10. Total Caesarean Section Surgeries

1.2.2. Mortality
- 1.2.2.1. Perinatal Deaths
- 1.2.2.2. Total in hospital Deaths

A.2 Hospitals Names

Hospital #	Hospital Name	Hospital #	Hospital Name
1	Riyadh Central	45	Albukairyah
3	Prince Salman	46	Almathneb
6	King Khalid - Alkharj	47	King Saud - Onaizah
7	Aflaj	48	Dammam Central
8	Hotat bany Tameem	50	Qateef
9	Wadi Dawasser	51	Jubail
10	King Khalid -Majmaah	52	King Fahd - hafuf
11	Zolfy	53	Price Saud bin
12	Quwaiah	54	King Khalid-hafer
13	Shaqra	55	Assir Central
14	Dawadmy	56	Khamees Mushait
15	Afif	58	Mahail
16	King Abd.ziz- Zaher	59	Dhahran Aljanoop
17	King Faisal -mecca	60	Ballasmer
19	AL Noor	61	Alnamas
20	Hiraa	62	Srat Obaidah
21	King Fahd -jiddah	63	Almajardah
22	King abd.ziz- jiddah	64	Tathleeth
25	Althagher	65	Rejal Almaa
26	Rabigh	66	Sabt Alalaya
27	Qunfuthah	67	Prince Abdullah
28	Adhum	68	King khalid - tabuk
29	King Faisal - taif	69	King Fahd - tabuk
32	King Fahd - Madinah	71	King khalid - hail
33	Ohud	72	Hail General
35	Prince Abd.Mohsen	73	Arar
36	Yanbu albahar	74	Rafha
37	Badr	75	King Fahd - jazan
38	Almahd	76	Jazan General
39	Khaybar	77	Sabia
40	Henakia	78	Abu Areesh
41	King Fahd - qassim	79	Samtah
42	Buraidah Central	80	Farasan
44	Alrrass	81	King khalid - najran
85	Baljirashy General	82	Najran General
87	Skaka	83	Sharorah
88	Tabarjal	84	King Fahd - baha
89	Alqurayat		

A.3.1 The Survey Questionnaire

Hospitals Survey

Dear Hospital Director

This Questionnaire is part of a Ph.D. dissertation; I am preparing on the hospital efficiency.

The purpose of this study is to assess the operating efficiency and quality of care in ministry of health hospitals.

Kindly answer all the questions accurately; hence the success of the study depends to a great deal on the accuracy of data given.

I would like to assure you that information provided in this Questionnaire will be treated as confidential, and be used for the purposes of the study only.

Thank you for your patience and co-operation.

Researcher

Ahmed Al-shaikh

Hospital: ____

Name of person completing the survey: ______________________________

Telephone #: ______________________________

1. The Hospital has an organizational chart defining the departments and lines of authority. (Would you attached a copy of the overall organizational chart)

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

2. It is frequently difficult to determine which staffs that are truly supervisors from the organizational chart.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

3. Administrative titles frequently reflect influence rather than supervisory responsibility.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

4. There are organized management and administrative functions implemented throughout the hospital, including the establishment of clear lines of responsibility and accountability within the departments/ services and between departments/ services./

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

5. Written job descriptions are provided for all workers. (Please attach a sample)

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

6. There are written policies and procedures that describe the role and scope of the department, its functions, how to do them and at what level of quality. (Please attach a sample)

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

Hospital: ______________________________

7. There is an ongoing review of the policies and procedures that focuses on problems and procedures related to the better utilization of resources.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

8. Policies and Procedures ongoing review is usually conducted through

- _____ Policies and Procedures Committee
- _____ The Departments and Units Internally by themselves
- _____ Others (specify):

9. The hospital implements a written plan that describes the utilization review program and governs its operation.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

10. The utilization review program addresses over-utilization, under-utilization and inefficient use of resources.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

11. Quality management activities in the hospital occur in formal committees with participants from more than one department or discipline. [Example of such committees are Infection control, Quality management, surgical care and committees of medical staff.]

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

Please list below the names of committees concerned with the performance and quality care in the hospital.

Hospital: ____

12. The hospital has a written plan for assessing and improving quality. The quality assessment plan describes the objectives, organizational scope and mechanism for overseeing the effectiveness of monitoring, evaluation and improvement activities.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

13. There is a systematic and effective mechanism for communciation between the administration, medical staff, nursing and nonmedical departments.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

14. The mechanism for communication in the hospital: (Tick as many types as are appropriate)

- _____ Formalized (using written forms)
- _____ Letters
- _____ Verbal/ Telephone Conversations
- _____ Committees
- _____ Computer network
- _____ Others

15. Necessary information is communicated among departments and professional disciplines.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

16. The hospital uses a computerized information system for clinical information. (Please specify the type of computers you have _____ Main frame, _____ PCs)

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

17. The hospital uses a computerized information system for non-clinical information. (Please specify the type of computers you have _____ Main frame, _____ PCs)

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

Hospital: ______________________________

18. Clinical procedures (admissions, discharge) and scheduling appointments are electronically executed and patient's information is retrieved electronically.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

19. Information related to administrative procedures like financial procedures (payroll, accounts) purchasing and inventory are electronically processed, maintained and retrieved.

___ Strongly disagree, ___ Disagree, ___ Not sure, ___ Agree, ___ Strongly agree

A.3.2 Survey instrument Reliability and Validity

According to Veney and Kaluzny (1984) validity and reliability have the property that increasing one generally leads to decreasing the other. Babbie (1989) states that survey research is generally weak on validity and strong on reliability.

Reliability of a survey measure refers to the stability and equivalence of repeated measures of the same concept (Aday 1989). According to Aday stability refers to the consistency of the answers people give to the same question when they are asked it at different points in time. And hence administering the same survey to the same people at two points in time (Hatcher and Stepanski 1994) can test reliability. However this requires some time and surveyed people interest in participating again. The Authors suggested another alternative, which are the internal consistency indices of reliability, where internal consistency is the extent to which the individual items of the survey correlate with one another or with survey total. They state that Coefficient Alpha in one of the most widely used indices of external consistency reliability in social science.

The reliability of the survey instrument was checked during the pilot testing in six hospitals. The hospital directors' answers were identical during the pilot test and the actual survey, and hence provided a check on the responder reliability in interpreting and answering the questions.

Moreover the reliability of the survey instrument was estimated by computing the coefficient alpha, which was 0.88. However, although there is no fixed level of consistency coefficient that indicates reliability, McDowell and Newell 1987 suggest that a coefficient of 0.85 or above are commonly taken as acceptable. Another rule of thumb of 0.7 that has been suggested by Nunnally (1978) where any estimate less than 0.7 is generally inadequate. Nevertheless as can be seen from table 13 the coefficient alpha estimates all exceeded 0.85, and hence the survey instrument is considered reliable.

Variables	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
ORGCH1	55.7162	104.0964	.5559	.8716
ORGCH2	56.1622	108.8227	.1670	.8825
ORGCH3	56.5811	109.3700	.1028	.8816
ORGCH4	56.1622	105.7268	.4256	.8749
JDISC	56.5541	98.2231	.6674	.8656
POLCP1	56.5811	97.8084	.6309	.8666
POLCP2	56.4459	99.2094	.6256	.8673
UTLZRV1	57.0676	96.6392	.6698	.8648
UTLZRV2	56.9189	98.4317	.6436	.8664
QM1	55.8919	101.7142	.6111	.8690
QM2	56.6892	97.3678	.6196	.8669
COM1	55.7838	107.7608	.4299	.8759
COM3	55.8649	106.2555	.3438	.8770
HIS1	57.7838	94.1718	.6158	.8670
HIS2	57.5405	95.3202	.5773	.8689
HIS3	57.2027	92.7364	.5984	.8689
HIS4	57.2162	94.8293	.5356	.8719

Reliability Coefficients

N of Cases – 74 N of Items = 17 Alpha = .8781

Table A1: Reliability Analysis – Scale (ALPHA)

Validity of survey questions refers to "the extent to which the measurement device being used actually taps or represents reality " (Veney and Kaluzny 1984). In another words are the questions measuring what they thought to measure. Validity can be tested on three aspects:

1. Content Validity
2. Criterion Validity
3. Construct Validity

However criterion and construct validity refer to the extent to which the survey measure agrees with some criterion of the true value of the measure or well developed theories about the relationships of that measure to others being measured, while content validity looks at whether the questions chosen are representative of the concepts they are intended to reflect (Aday 1989; Streiner and Norman 1989; Veney and Kaluzny 1984).

The survey questions were intended to reflect the extent to which the organizational elements related to performance were available and used in the management process, to be utilized as a tool for comparison between the types of management, but not intended to examine the degree of agreement with known criterion or test a theoretical relationships. Therefore the content validity of the survey questions were examined.

The validity of the survey questions was checked using the technique suggested by Forcese and Richer (1973) called " *random probes*", a technique developed by Schuman which requires the surveyor to carry out "*follow up probes*" for a set of closed questions. They do not replace the question but follow immediately after the respondent choice of an alternative to reflect what he had in mind in making his choice. The follow up probes used in this research survey questionnaire were mainly asking the respondent to attach a hard copy of the information regarding the question being asked, for example attaching a copy of the organizational chart, a sample of the policies and procedures or responding to an open ended questions such as listing the names of committees concerned with quality of care that are active in the hospital or defining the mechanisms for communication used in the hospital.

Reviewing the answers given to the survey questions with the attachments related to the questions or the written comments in responding to the open ended questions displayed an understanding of the questions.

To examine the content validity of the survey questions to see if the survey questions reflect the components they were intended to measure, factor analysis was used, the method is called "*factorial validity*" (Price and Mueller 1986; McDowell and Newell 1987). Factor analysis explores the dimensionality of the survey items and the distinctiveness of the components. As can be seen from table A.2, each of the 5 factors stemming from the factor analysis can be said to map reasonably closely with the dimensions of organizational elements defined in chapter 4. By looking at the items loaded highly in each factor, it was found that Components 3 and 5 are stressing organizational chart issues, component 1 is stressing work specification activities, component 4 is stressing communication and component 2 is stressing hospital information system.

	Components				
Variables	1	2	3	4	5
ORGCH1	0.33260	0.17464	0.47910	0.47643	-0.15427
ORGCH2	-0.05198	-0.14389	0.61657	0.36891	0.39439
ORGCH3	0.04084	0.10634	0.04157	0.00017	0.89053
ORGCH4	0.20842	0.09954	0.86679	-0.00001	0.04875
JDISC	0.69133	0.24042	0.34960	0.08002	-0.13121
POLCP1	0.59981	0.18654	0.48017	0.15085	-0.19762
POLCP2	0.60753	0.19737	0.44712	0.10299	-0.11253
UTLZRV1	0.88424	0.13357	0.05064	0.12862	0.08873
UTLZRV2	0.84835	0.15404	-0.00467	0.12350	0.12271
QM1	0.64460	0.24735	-0.00519	0.32435	0.02566
QM2	0.80852	0.15166	0.14528	0.03019	0.01184
COM1	0.26276	0.11709	0.04768	0.71816	0.16393
COM3	0.07136	0.12992	0.11844	0.80332	-0.08659
HIS1	0.27296	0.82902	0.05046	0.00387	-0.03161
HIS2	0.10662	0.86859	0.10395	0.08448	0.10278
HIS3	0.17312	0.83003	0.06341	0.19646	-0.07286
HIS4	0.20078	0.74844	0.0116	0.09690	0.09708

Table A.2: Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 8 iterations.

APPENDIX B

DEA Potential Improvements Report

* Report structure shows the hospital number and efficiency score on the top left side followed by actual, target and potential improvement by each input and output variable.

BCC Efficiency Report

6 98.46%

	Actual:	Target:	Potential improvement:
TBEDDAYS	83898.00	79985.43	-04.66%
DISCH_T	14846.00	14678.93	-01.13%
INPDAYS	69635.00	68589.21	-01.50%
OPEMVIST	193660.50	194751.14	00.56%
SURG_TYP	15.00	14.75	-01.69%
SURGMAJR	3123.67	3082.89	-01.31%
SURGMINR	2265.00	3449.52	52.30%
TOTSURGN	15.00	12.35	-17.69%
NONSURGM	48.00	49.62	03.38%
TOTNURS	242.00	202.74	-16.22%
NMSTF	246.00	254.89	03.61%

7 74.20%

	Actual:	Target:	Potential improvement:
TBEDDAYS	43070.00	33156.44	-23.02%
DISCH_T	6594.00	6505.73	-01.34%
INPDAYS	27931.00	25686.89	-08.03%
OPEMVIST	78158.50	162984.33	108.53%
SURG_TYP	13.67	12.57	-08.03%
SURGMAJR	696.00	905.58	30.11%
SURGMINR	856.33	2547.48	197.49%
TOTSURGN	8.00	6.18	-22.71%
NONSURGM	27.00	16.27	-39.74%
TOTNURS	105.00	70.66	-32.71%
NMSTF	294.00	102.34	-65.19%

8 98.65%

	Actual:	Target:	Potential improvement:
TBEDDAYS	20886.00	21517.70	03.02%
DISCH_T	4052.00	4525.49	11.69%
INPDAYS	16266.00	14855.37	-08.67%
OPEMVIST	65716.17	95864.69	45.88%
SURG_TYP	9.67	9.70	00.28%
SURGMAJR	512.00	457.25	-10.69%
SURGMINR	608.33	1722.74	183.19%
TOTSURGN	5.00	4.35	-12.95%
NONSURGM	18.00	14.10	-21.69%
TOTNURS	66.00	50.07	-24.13%
NMSTF	120.00	104.33	-13.06%

9 61.23%

	Actual:	Target:	Potential improvement:
TBEDDAYS	37878.00	23661.02	-37.53%
DISCH_T	4999.00	4763.72	-04.71%
INPDAYS	16540.00	16540.68	00.00%
OPEMVIST	117734.33	115919.56	-01.54%
SURG_TYP	10.67	10.22	-04.21%
SURGMAJR	561.00	512.01	-08.73%
SURGMINR	395.00	1719.15	335.23%
TOTSURGN	7.00	4.39	-37.24%
NONSURGM	23.00	14.54	-36.78%
TOTNURS	103.00	48.63	-52.79%

9 61.23%

NMSTF	138.00	86.96	-36.99%

10 75.69%

	Actual:	Target:	Potential improvement:
TBEDDAYS	70210.00	51125.64	-27.18%
DISCH_T	10072.00	10196.86	01.24%
INPDAYS	44486.00	43117.21	-03.08%
OPEMVIST	146261.00	141760.69	-03.08%
SURG_TYP	14.33	13.89	-03.08%
SURGMAJR	1998.67	1950.42	-02.41%
SURGMINR	1272.33	3010.93	136.65%
TOTSURGN	10.00	8.19	-18.13%
NONSURGM	57.00	31.82	-44.17%
TOTNURS	202.00	130.20	-35.54%
NMSTF	419.00	210.63	-49.73%

11 86.07%

	Actual:	Target:	Potential improvement:
TBEDDAYS	53100.00	37787.11	-28.84%
DISCH_T	5300.00	8245.21	55.57%
INPDAYS	21948.00	32601.15	48.54%
OPEMVIST	130130.83	180012.23	38.33%
SURG_TYP	12.67	11.28	-10.96%
SURGMAJR	1535.67	1363.51	-11.21%
SURGMINR	914.00	2264.00	147.70%
TOTSURGN	6.00	5.84	-02.60%
NONSURGM	53.00	22.36	-57.82%
TOTNURS	100.00	87.92	-12.08%
NMSTF	166.00	131.26	-20.93%

12 94.69%

	Actual:	Target:	Potential improvement:
TBEDDAYS	43542.00	38842.20	-10.79%
DISCH_T	6011.00	7286.55	21.22%
INPDAYS	27188.00	28556.86	05.03%
OPEMVIST	99121.00	95985.75	-03.16%
SURG_TYP	11.67	13.42	14.98%
SURGMAJR	1733.00	1685.92	-02.72%
SURGMINR	1881.00	1964.83	04.46%
TOTSURGN	10.00	8.43	-15.66%
NONSURGM	21.00	21.29	01.36%
TOTNURS	111.00	87.36	-21.30%
NMSTF	108.00	105.40	-02.41%

13 68.91%

	Actual:	Target:	Potential improvement:
TBEDDAYS	40474.00	28363.69	-29.92%
DISCH_T	4651.00	5609.35	20.61%
INPDAYS	22461.00	21045.78	-06.30%
OPEMVIST	114531.17	142177.74	24.14%
SURG_TYP	11.00	11.36	03.24%
SURGMAJR	778.33	723.40	-07.06%
SURGMINR	1164.33	2097.15	80.12%

13 68.91%

TOTSURGN	8.00	5.19	-35.10%
NONSURGM	29.00	13.48	-53.52%
TOTNURS	79.00	55.36	-29.92%
NMSTF	118.00	76.67	-35.02%

15 85.61%

	Actual:	Target:	Potential improvement:
TBEDDAYS	38940.00	35086.00	-09.90%
DISCH_T	5818.00	6874.81	18.16%
INPDAYS	23104.00	26388.85	14.22%
OPEMVIST	67653.67	110059.25	62.68%
SURG_TYP	13.00	12.40	-04.61%
SURGMAJR	1460.67	1387.78	-04.99%
SURGMINR	1469.33	1987.83	35.29%
TOTSURGN	8.00	7.24	-09.47%
NONSURGM	28.00	19.86	-29.07%
TOTNURS	122.00	80.17	-34.29%
NMSTF	265.00	109.54	-58.66%

16 60.51%

	Actual:	Target:	Potential improvement:
TBEDDAYS	102660.00	64832.06	-36.85%
DISCH_T	10722.00	16294.67	51.97%
INPDAYS	65419.00	61506.38	-05.98%
OPEMVIST	302606.17	284507.72	-05.98%
SURG_TYP	14.67	14.37	-02.08%
SURGMAJR	1485.00	2889.70	94.59%
SURGMINR	1330.67	1251.08	-05.98%
TOTSURGN	28.00	17.58	-37.22%
NONSURGM	123.00	52.45	-57.36%
TOTNURS	333.00	160.40	-51.83%
NMSTF	458.00	231.65	-49.42%

17 66.02%

	Actual:	Target:	Potential improvement:
TBEDDAYS	77880.00	52798.18	-32.21%
DISCH_T	7539.00	10974.07	45.56%
INPDAYS	37815.00	43760.72	15.72%
OPEMVIST	272642.67	241558.48	-11.40%
SURG_TYP	9.33	13.45	44.13%
SURGMAJR	1412.33	1364.51	-03.39%
SURGMINR	676.67	2039.75	201.44%
TOTSURGN	17.00	9.96	-41.43%
NONSURGM	40.00	27.78	-30.55%
TOTNURS	226.00	114.20	-49.47%
NMSTF	268.00	177.02	-33.95%

19 60.43%

	Actual:	Target:	Potential improvement:
TBEDDAYS	191514.00	126451.80	-33.97%
DISCH_T	19912.00	32766.34	64.56%
INPDAYS	142359.00	133020.74	-06.56%
OPEMVIST	270165.17	336283.10	24.47%
SURG_TYP	18.67	16.97	-09.09%
SURGMAJR	4099.33	8559.53	108.80%
SURGMINR	1666.00	1502.05	-09.84%
TOTSURGN	54.00	23.92	-55.70%
NONSURGM	374.00	127.20	-65.99%
TOTNURS	870.00	422.41	-51.45%
NMSTF	1423.00	677.19	-52.41%

20 64.16%

	Actual:	Target:	Potential improvement:
TBEDDAYS	93220.00	65632.88	-29.59%
DISCH_T	14943.00	15806.94	05.78%
INPDAYS	70485.00	64650.31	-08.28%
OPEMVIST	193364.00	231774.22	19.86%
SURG_TYP	11.67	13.11	12.35%
SURGMAJR	2522.67	3793.13	50.36%
SURGMINR	805.00	2389.31	196.81%
TOTSURGN	22.00	10.28	-53.26%
NONSURGM	206.00	54.95	-73.32%
TOTNURS	380.00	202.78	-46.64%
NMSTF	528.00	322.22	-38.97%

21 57.49%

	Actual:	Target:	Potential improvement:
TBEDDAYS	254526.00	160710.26	-36.86%
DISCH_T	13095.00	32998.08	151.99%
INPDAYS	178127.00	158453.96	-11.04%
OPEMVIST	243128.17	294531.52	21.14%
SURG_TYP	14.00	16.27	16.23%
SURGMAJR	9077.00	8481.09	-06.57%
SURGMINR	1226.00	2126.79	73.47%
TOTSURGN	104.00	22.38	-78.48%
NONSURGM	556.00	131.21	-76.40%
TOTNURS	759.00	476.57	-37.21%
NMSTF	1579.00	712.82	-54.86%

22 77.45%

	Actual:	Target:	Potential improvement:
TBEDDAYS	160008.00	101431.49	-36.61%
DISCH_T	14789.00	24124.61	63.13%
INPDAYS	107692.00	100028.80	-07.12%
OPEMVIST	199074.83	237214.15	19.16%
SURG_TYP	17.33	15.80	-08.84%
SURGMAJR	3335.33	6564.54	96.82%
SURGMINR	2444.33	3150.14	28.88%
TOTSURGN	17.00	15.84	-06.80%
NONSURGM	111.00	94.96	-14.45%
TOTNURS	642.00	344.17	-46.39%

22 77.45%

NMSTF	889.00	550.29	-38.10%

25 61.87%

	Actual:	Target:	Potential improvement:
TBEDDAYS	48970.00	34504.58	-29.54%
DISCH_T	6093.00	6635.29	08.90%
INPDAYS	31995.00	24010.63	-24.96%
OPEMVIST	182233.67	107005.47	-41.28%
SURG_TYP	11.33	11.85	04.57%
SURGMAJR	2283.00	1169.61	-48.77%
SURGMINR	142.00	2983.48	2001.04%
TOTSURGN	40.00	6.37	-84.07%
NONSURGM	70.00	22.07	-68.47%
TOTNURS	148.00	91.95	-37.87%
NMSTF	300.00	136.06	-54.65%

26 64.06%

	Actual:	Target:	Potential improvement:
TBEDDAYS	49678.00	32747.16	-34.08%
DISCH_T	7211.00	6741.73	-06.51%
INPDAYS	25180.00	26416.75	04.91%
OPEMVIST	117896.33	183041.13	55.26%
SURG_TYP	11.33	11.79	04.03%
SURGMAJR	845.33	806.84	-04.55%
SURGMINR	913.67	2471.91	170.55%
TOTSURGN	8.00	5.30	-33.73%
NONSURGM	35.00	13.53	-61.35%
TOTNURS	95.00	62.99	-33.70%
NMSTF	270.00	88.12	-67.36%

27 83.61%

	Actual:	Target:	Potential improvement:
TBEDDAYS	48852.00	42956.20	-12.07%
DISCH_T	11422.00	10063.71	-11.89%
INPDAYS	39244.00	38576.42	-01.70%
OPEMVIST	158923.17	218474.03	37.47%
SURG_TYP	13.33	12.95	-02.84%
SURGMAJR	1380.67	1486.39	07.66%
SURGMINR	382.33	2052.97	436.96%
TOTSURGN	11.00	9.68	-12.04%
NONSURGM	40.00	25.16	-37.10%
TOTNURS	136.00	90.91	-33.15%
NMSTF	331.00	117.12	-64.62%

28 67.03%

	Actual:	Target:	Potential improvement:
TBEDDAYS	42362.00	24803.38	-41.45%
DISCH_T	5234.00	4867.93	-06.99%
INPDAYS	19594.00	17465.25	-10.86%
OPEMVIST	111289.50	130911.00	17.63%
SURG_TYP	11.67	10.52	-09.82%
SURGMAJR	444.33	506.58	14.01%
SURGMINR	300.33	1553.04	417.11%

28 67.03%

TOTSURGN	7.00	4.41	-36.98%
NONSURGM	20.00	14.66	-26.69%
TOTNURS	63.00	45.82	-27.28%
NMSTF	242.00	66.22	-72.63%

29 79.19%

	Actual:	Target:	Potential improvement:
TBEDDAYS	167088.00	128295.59	-23.22%
DISCH_T	18620.00	19308.18	03.70%
INPDAYS	112100.00	111387.30	-00.64%
OPEMVIST	229107.83	227450.63	-00.72%
SURG_TYP	14.67	14.85	01.25%
SURGMAJR	2936.67	3263.00	11.11%
SURGMINR	2289.33	2274.00	-00.67%
TOTSURGN	31.00	18.16	-41.42%
NONSURGM	113.00	66.00	-41.59%
TOTNURS	410.00	261.84	-36.14%
NMSTF	317.00	282.86	-10.77%

32 62.72%

	Actual:	Target:	Potential improvement:
TBEDDAYS	173460.00	114441.70	-34.02%
DISCH_T	12788.00	25322.60	98.02%
INPDAYS	126626.00	112208.10	-11.39%
OPEMVIST	207664.17	297159.02	43.10%
SURG_TYP	14.33	16.27	13.51%
SURGMAJR	4295.33	5502.89	28.11%
SURGMINR	576.00	1356.09	135.43%
TOTSURGN	61.00	22.08	-63.80%
NONSURGM	176.00	90.21	-48.74%
TOTNURS	460.00	304.31	-33.85%
NMSTF	1458.00	429.51	-70.54%

33 73.58%

	Actual:	Target:	Potential improvement:
TBEDDAYS	81656.00	58090.27	-28.86%
DISCH_T	11777.00	13727.08	16.56%
INPDAYS	42269.00	52685.20	24.64%
OPEMVIST	84428.67	194765.05	130.69%
SURG_TYP	10.67	14.83	39.01%
SURGMAJR	2970.00	2730.44	-08.07%
SURGMINR	1506.00	1384.53	-08.07%
TOTSURGN	23.00	14.93	-35.08%
NONSURGM	87.00	42.61	-51.02%
TOTNURS	176.00	138.17	-21.50%
NMSTF	531.00	180.64	-65.98%

35 75.74%

	Actual:	Target:	Potential improvement:
TBEDDAYS	39648.00	29645.09	-25.23%
DISCH_T	6227.00	6044.16	-02.94%
INPDAYS	28414.00	23348.59	-17.83%
OPEMVIST	52759.33	171144.55	224.39%
SURG_TYP	11.67	11.04	-05.39%
SURGMAJR	462.33	649.59	40.50%
SURGMINR	430.67	2337.13	442.67%
TOTSURGN	10.00	4.67	-53.33%
NONSURGM	29.00	12.00	-58.63%
TOTNURS	64.00	54.45	-14.92%
NMSTF	325.00	72.66	-77.64%

36 93.70%

	Actual:	Target:	Potential improvement:
TBEDDAYS	36698.00	34808.86	-05.15%
DISCH_T	6326.00	7392.87	16.86%
INPDAYS	25644.00	29105.12	13.50%
OPEMVIST	196343.67	190646.31	-02.90%
SURG_TYP	12.33	11.95	-03.10%
SURGMAJR	1088.67	1045.76	-03.94%
SURGMINR	1980.67	2561.99	29.35%
TOTSURGN	6.00	5.81	-03.09%
NONSURGM	29.00	16.25	-43.97%
TOTNURS	77.00	74.50	-03.25%
NMSTF	178.00	99.77	-43.95%

41 62.26%

	Actual:	Target:	Potential improvement:
TBEDDAYS	163194.00	98308.27	-39.76%
DISCH_T	15718.00	24107.19	53.37%
INPDAYS	107712.00	97162.57	-09.79%
OPEMVIST	300656.50	270190.79	-10.13%
SURG_TYP	18.33	16.25	-11.36%
SURGMAJR	4542.33	6067.09	33.57%
SURGMINR	684.00	2598.88	279.95%
TOTSURGN	41.00	18.55	-54.76%
NONSURGM	216.00	90.31	-58.19%
TOTNURS	477.00	313.67	-34.24%
NMSTF	1230.00	477.08	-61.21%

42 53.52%

	Actual:	Target:	Potential improvement:
TBEDDAYS	70800.00	41245.23	-41.74%
DISCH_T	6348.00	8545.30	34.61%
INPDAYS	36580.00	33862.80	-07.43%
OPEMVIST	200240.50	185366.45	-07.43%
SURG_TYP	11.00	12.69	15.34%
SURGMAJR	646.33	1510.74	133.74%
SURGMINR	3300.33	3055.18	-07.43%
TOTSURGN	16.00	6.90	-56.87%
NONSURGM	72.00	22.73	-68.43%
TOTNURS	245.00	100.82	-58.85%

42 53.52%

NMSTF	665.00	131.83	-80.18%

45 67.94%

	Actual:	Target:	Potential improvement:
TBEDDAYS	48026.00	35195.19	-26.72%
DISCH_T	9696.00	7775.33	-19.81%
INPDAYS	28678.00	29817.55	03.97%
OPEMVIST	86394.67	200215.53	131.75%
SURG_TYP	11.33	12.27	08.33%
SURGMAJR	989.33	959.13	-03.05%
SURGMINR	314.33	2301.24	632.11%
TOTSURGN	12.00	7.20	-39.97%
NONSURGM	41.00	16.32	-60.21%
TOTNURS	141.00	67.76	-51.94%
NMSTF	327.00	83.06	-74.60%

46 67.22%

	Actual:	Target:	Potential improvement:
TBEDDAYS	44604.00	31930.89	-28.41%
DISCH_T	7763.00	6785.14	-12.60%
INPDAYS	24627.00	26282.16	06.72%
OPEMVIST	91940.33	175136.16	90.49%
SURG_TYP	12.67	11.49	-09.31%
SURGMAJR	1057.67	923.52	-12.68%
SURGMINR	454.67	2416.16	431.41%
TOTSURGN	10.00	5.36	-46.43%
NONSURGM	49.00	15.27	-68.83%
TOTNURS	121.00	68.53	-43.37%
NMSTF	257.00	97.83	-61.93%

47 58.14%

	Actual:	Target:	Potential improvement:
TBEDDAYS	104194.00	64616.59	-37.98%
DISCH_T	13034.00	15553.89	19.33%
INPDAYS	54340.00	58643.08	07.92%
OPEMVIST	237526.83	248811.47	04.75%
SURG_TYP	16.33	15.85	-02.92%
SURGMAJR	2356.00	2699.09	14.56%
SURGMINR	1798.67	2132.32	18.55%
TOTSURGN	28.00	17.20	-38.56%
NONSURGM	117.00	46.45	-60.30%
TOTNURS	347.00	150.46	-56.64%
NMSTF	726.00	180.36	-75.16%

48 59.51%

	Actual:	Target:	Potential improvement:
TBEDDAYS	153990.00	94896.01	-38.38%
DISCH_T	13156.00	23379.09	77.71%
INPDAYS	92394.00	93597.29	01.30%
OPEMVIST	270651.33	272426.33	00.66%
SURG_TYP	17.00	16.24	-04.45%
SURGMAJR	5754.67	5696.70	-01.01%
SURGMINR	2521.67	2415.99	-04.19%

48 59.51%

TOTSURGN	32.00	18.80	-41.25%
NONSURGM	147.00	85.89	-41.57%
TOTNURS	611.00	294.63	-51.78%
NMSTF	932.00	442.68	-52.50%

50 91.14%

	Actual:	Target:	Potential improvement:
TBEDDAYS	117882.00	83111.81	-29.50%
DISCH_T	15135.00	20447.14	35.10%
INPDAYS	72301.00	80269.64	11.02%
OPEMVIST	174349.67	266850.13	53.05%
SURG_TYP	17.33	16.12	-06.97%
SURGMAJR	3502.00	4506.04	28.67%
SURGMINR	1476.33	2194.20	48.63%
TOTSURGN	18.00	18.50	02.76%
NONSURGM	117.00	70.56	-39.69%
TOTNURS	318.00	236.45	-25.64%
NMSTF	317.00	337.01	06.31%

51 47.21%

	Actual:	Target:	Potential improvement:
TBEDDAYS	67260.00	33556.81	-50.11%
DISCH_T	6220.00	7123.56	14.53%
INPDAYS	34527.00	28054.66	-18.75%
OPEMVIST	147613.00	189197.89	28.17%
SURG_TYP	13.67	11.81	-13.63%
SURGMAJR	921.00	984.86	06.93%
SURGMINR	317.00	2543.57	702.39%
TOTSURGN	16.00	5.50	-65.63%
NONSURGM	63.00	15.15	-75.94%
TOTNURS	170.00	70.78	-58.36%
NMSTF	340.00	94.75	-72.13%

53 90.61%

	Actual:	Target:	Potential improvement:
TBEDDAYS	36816.00	37977.88	03.16%
DISCH_T	7823.00	8299.86	06.10%
INPDAYS	34607.00	33192.01	-04.09%
OPEMVIST	187088.00	192474.94	02.88%
SURG_TYP	11.00	11.99	09.00%
SURGMAJR	1408.33	1353.41	-03.90%
SURGMINR	1384.00	2475.84	78.89%
TOTSURGN	15.00	6.14	-59.06%
NONSURGM	46.00	20.60	-55.21%
TOTNURS	131.00	88.31	-32.59%
NMSTF	411.00	128.05	-68.84%

54 86.92%

	Actual:	Target:	Potential improvement:
TBEDDAYS	95698.00	70690.38	-26.13%
DISCH_T	15505.00	15919.95	02.68%
INPDAYS	72093.00	64678.37	-10.28%
OPEMVIST	256305.00	230135.71	-10.21%
SURG_TYP	16.00	14.34	-10.35%
SURGMAJR	2466.67	3587.17	45.43%
SURGMINR	609.33	2875.31	371.88%
TOTSURGN	12.00	11.80	-01.68%
NONSURGM	72.00	54.58	-24.19%
TOTNURS	310.00	208.55	-32.73%
NMSTF	417.00	318.11	-23.71%

55 68.09%

	Actual:	Target:	Potential improvement:
TBEDDAYS	174994.00	122273.88	-30.13%
DISCH_T	13602.00	25491.19	87.41%
INPDAYS	121266.00	114583.67	-05.51%
OPEMVIST	298499.83	280951.00	-05.88%
SURG_TYP	16.00	14.94	-06.65%
SURGMAJR	4492.00	6214.64	38.35%
SURGMINR	2967.33	2803.51	-05.52%
TOTSURGN	37.00	19.20	-48.12%
NONSURGM	221.00	100.76	-54.41%
TOTNURS	507.00	354.05	-30.17%
NMSTF	758.00	508.65	-32.90%

60 80.57%

	Actual:	Target:	Potential improvement:
TBEDDAYS	38940.00	27797.55	-28.61%
DISCH_T	5018.00	5416.28	07.94%
INPDAYS	22975.00	21599.04	-05.99%
OPEMVIST	93604.00	158942.52	69.80%
SURG_TYP	13.33	11.99	-10.05%
SURGMAJR	544.67	588.70	08.08%
SURGMINR	497.67	2106.73	323.32%
TOTSURGN	6.00	5.19	-13.45%
NONSURGM	25.00	12.35	-50.60%
TOTNURS	60.00	52.76	-12.07%
NMSTF	220.00	88.92	-59.58%

61 65.50%

	Actual:	Target:	Potential improvement:
TBEDDAYS	44604.00	29778.98	-33.24%
DISCH_T	5586.00	6075.30	08.76%
INPDAYS	24681.00	23763.07	-03.72%
OPEMVIST	99780.83	180178.16	80.57%
SURG_TYP	15.00	11.72	-21.85%
SURGMAJR	861.67	673.43	-21.85%
SURGMINR	269.00	2479.16	821.62%
TOTSURGN	9.00	5.03	-44.09%
NONSURGM	31.00	11.24	-63.73%
TOTNURS	82.00	56.24	-31.42%

61 65.50%

NMSTF	213.00	74.11	-65.21%

64 72.50%

	Actual:	Target:	Potential improvement:
TBEDDAYS	31860.00	23819.81	-25.24%
DISCH_T	5144.00	4938.14	-04.00%
INPDAYS	20709.00	17311.08	-16.41%
OPEMVIST	94714.50	123559.27	30.45%
SURG_TYP	11.67	10.31	-11.69%
SURGMAJR	549.00	491.12	-10.54%
SURGMINR	263.33	1991.57	656.30%
TOTSURGN	8.00	4.49	-43.88%
NONSURGM	20.00	12.53	-37.34%
TOTNURS	72.00	50.36	-30.05%
NMSTF	190.00	90.41	-52.42%

65 87.49%

	Actual:	Target:	Potential improvement:
TBEDDAYS	21240.00	19193.54	-09.63%
DISCH_T	3215.00	3766.70	17.16%
INPDAYS	13027.00	11491.22	-11.79%
OPEMVIST	63440.67	81930.86	29.15%
SURG_TYP	9.00	9.26	02.93%
SURGMAJR	372.00	329.95	-11.30%
SURGMINR	266.33	1197.68	349.70%
TOTSURGN	5.00	3.74	-25.28%
NONSURGM	26.00	16.24	-37.52%
TOTNURS	44.00	40.20	-08.63%
NMSTF	158.00	90.00	-43.04%

66 76.81%

	Actual:	Target:	Potential improvement:
TBEDDAYS	35400.00	24610.02	-30.48%
DISCH_T	4471.00	4790.11	07.14%
INPDAYS	14160.00	17160.82	21.19%
OPEMVIST	89709.83	134483.76	49.91%
SURG_TYP	12.67	10.41	-17.86%
SURGMAJR	590.67	496.04	-16.02%
SURGMINR	224.00	1584.37	607.31%
TOTSURGN	5.00	4.07	-18.53%
NONSURGM	19.00	15.59	-17.94%
TOTNURS	67.00	44.50	-33.58%
NMSTF	136.00	69.95	-48.57%

67 65.04%

	Actual:	Target:	Potential improvement:
TBEDDAYS	109150.00	66941.71	-38.67%
DISCH_T	14243.00	14377.71	00.95%
INPDAYS	64421.00	64219.87	-00.31%
OPEMVIST	187920.00	194697.06	03.61%
SURG_TYP	13.67	14.15	03.52%
SURGMAJR	2286.67	2279.40	-00.32%
SURGMINR	945.67	942.31	-00.35%

67 65.04%

TOTSURGN	20.00	13.58	-32.11%
NONSURGM	87.00	43.98	-49.45%
TOTNURS	209.00	142.90	-31.63%
NMSTF	661.00	240.26	-63.65%

68 73.82%

	Actual:	Target:	Potential improvement:
TBEDDAYS	77644.00	61520.64	-20.77%
DISCH_T	10880.00	15616.65	43.54%
INPDAYS	61624.00	58612.34	-04.89%
OPEMVIST	129723.83	268665.07	107.11%
SURG_TYP	16.00	15.22	-04.89%
SURGMAJR	2241.33	2504.73	11.75%
SURGMINR	1395.33	1327.14	-04.89%
TOTSURGN	28.00	17.39	-37.88%
NONSURGM	91.00	44.69	-50.89%
TOTNURS	240.00	134.07	-44.14%
NMSTF	490.00	165.83	-66.16%

71 90.24%

	Actual:	Target:	Potential improvement:
TBEDDAYS	74340.00	72331.78	-02.70%
DISCH_T	16778.00	18675.05	11.31%
INPDAYS	74340.00	71754.55	-03.48%
OPEMVIST	181568.83	285450.84	57.21%
SURG_TYP	16.00	15.42	-03.65%
SURGMAJR	3101.33	3522.85	13.59%
SURGMINR	831.00	1169.76	40.77%
TOTSURGN	25.00	18.68	-25.29%
NONSURGM	89.00	58.85	-33.88%
TOTNURS	275.00	180.91	-34.22%
NMSTF	521.00	251.67	-51.69%

75 88.61%

	Actual:	Target:	Potential improvement:
TBEDDAYS	143606.00	112791.87	-21.46%
DISCH_T	12824.00	17677.11	37.84%
INPDAYS	116744.00	95330.42	-18.34%
OPEMVIST	109562.00	215449.02	96.65%
SURG_TYP	17.67	14.43	-18.34%
SURGMAJR	4130.33	3372.73	-18.34%
SURGMINR	430.00	3201.30	644.49%
TOTSURGN	42.00	15.63	-62.78%
NONSURGM	121.00	63.70	-47.36%
TOTNURS	343.00	253.01	-26.24%
NMSTF	255.00	288.01	12.94%

76 92.86%

	Actual:	Target:	Potential improvement:
TBEDDAYS	44604.00	42638.97	-04.41%
DISCH_T	9332.00	9328.63	-00.04%
INPDAYS	37765.00	35803.49	-05.19%
OPEMVIST	142718.83	192699.34	35.02%
SURG_TYP	14.33	13.59	-05.19%
SURGMAJR	1488.00	1416.59	-04.80%
SURGMINR	789.33	2350.31	197.76%
TOTSURGN	11.00	9.78	-11.09%
NONSURGM	26.00	25.17	-03.20%
TOTNURS	110.00	92.55	-15.86%
NMSTF	286.00	120.82	-57.75%

77 74.69%

	Actual:	Target:	Potential improvement:
TBEDDAYS	44250.00	35089.91	-20.70%
DISCH_T	9333.00	7742.44	-17.04%
INPDAYS	29500.00	29699.68	00.68%
OPEMVIST	158923.33	199889.11	25.78%
SURG_TYP	13.00	12.26	-05.68%
SURGMAJR	861.33	953.48	10.70%
SURGMINR	314.33	2306.70	633.85%
TOTSURGN	11.00	7.16	-34.93%
NONSURGM	25.00	16.20	-35.19%
TOTNURS	129.00	67.53	-47.65%
NMSTF	250.00	82.80	-66.88%

81 91.01%

	Actual:	Target:	Potential improvement:
TBEDDAYS	100890.00	86667.11	-14.10%
DISCH_T	21325.00	20905.18	-01.97%
INPDAYS	89120.00	87365.51	-01.97%
OPEMVIST	219871.33	249775.85	13.60%
SURG_TYP	15.00	14.70	-01.97%
SURGMAJR	3519.00	4806.96	36.60%
SURGMINR	1282.33	1519.83	18.52%
TOTSURGN	17.00	15.80	-07.03%
NONSURGM	81.00	75.14	-07.23%
TOTNURS	274.00	253.44	-07.50%
NMSTF	557.00	415.73	-25.36%

82 69.03%

	Actual:	Target:	Potential improvement:
TBEDDAYS	53100.00	39327.39	-25.94%
DISCH_T	9491.00	8784.10	-07.45%
INPDAYS	37524.00	34588.09	-07.82%
OPEMVIST	146173.67	201034.91	37.53%
SURG_TYP	12.00	12.23	01.92%
SURGMAJR	1107.67	1410.16	27.31%
SURGMINR	714.33	2405.06	236.69%
TOTSURGN	11.00	7.05	-35.91%
NONSURGM	62.00	21.90	-64.67%
TOTNURS	159.00	89.92	-43.45%

82 69.03%

NMSTF	410.00	124.66	-69.60%

83 88.31%

	Actual:	Target:	Potential improvement:
TBEDDAYS	26550.00	25521.75	-03.87%
DISCH_T	5206.00	5088.88	-02.25%
INPDAYS	20090.00	19244.21	-04.21%
OPEMVIST	123387.67	120868.20	-02.04%
SURG_TYP	11.67	11.19	-04.10%
SURGMAJR	654.33	626.54	-04.25%
SURGMINR	587.00	1712.85	191.80%
TOTSURGN	8.00	5.16	-35.51%
NONSURGM	35.00	15.82	-54.79%
TOTNURS	84.00	56.37	-32.89%
NMSTF	219.00	116.04	-47.01%

84 52.01%

	Actual:	Target:	Potential improvement:
TBEDDAYS	144432.00	75906.39	-47.44%
DISCH_T	14394.00	17784.24	23.55%
INPDAYS	82704.00	72303.19	-12.58%
OPEMVIST	144857.00	227433.30	57.01%
SURG_TYP	16.67	14.52	-12.91%
SURGMAJR	3221.67	4431.51	37.55%
SURGMINR	641.33	3025.41	371.74%
TOTSURGN	32.00	12.58	-60.67%
NONSURGM	132.00	64.44	-51.18%
TOTNURS	455.00	239.13	-47.44%
NMSTF	694.00	362.65	-47.74%

85 69.34%

	Actual:	Target:	Potential improvement:
TBEDDAYS	61596.00	32031.41	-48.00%
DISCH_T	5726.00	6468.89	12.97%
INPDAYS	25460.00	25108.70	-01.38%
OPEMVIST	134441.33	166924.15	24.16%
SURG_TYP	12.33	12.10	-01.83%
SURGMAJR	745.33	877.31	17.71%
SURGMINR	2441.33	2396.76	-01.83%
TOTSURGN	18.00	5.95	-66.93%
NONSURGM	27.00	13.04	-51.70%
TOTNURS	71.00	61.93	-12.77%
NMSTF	315.00	74.67	-76.29%