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Creation of an e-business requirements specification model

John Dilworth and A.K. Kochhar
School of Engineering and Applied Science, Aston University, Birmingham, UK

Received December 2005
Revised July 2006
Accepted October 2006

Abstract

Purpose – This paper aims to describe the creation of an e-business functional requirements definition model using a case study process.

Design/methodology/approach – The creation of this model was the subject of a research project, the hypothesis of which is that it is possible to produce a model that can be used in real life situations to specify, using objective reasoning, the e-business requirements of an organisation.

Findings – The research demonstrated a practical method of creating and refining this model and further was able to demonstrate that there were reasonable prospects of converging towards a stable model.

Research limitations/implications – The paper has demonstrated that it has produced an acceptable model by using a case study process that gives sound results. It is also felt that it has validated the basic research method that was adopted.

Practical implications – An innovative tool has been created whereby a specification of e-business requirements can be created in a matter of a few hours, compared with the weeks' or months' worth of effort often involved in the use of the traditional business systems analysis process. Based on the operating characteristics of a company and the concerns of its management, the specification avoids the prejudices of consultants and vested interests of salesmen.

Originality/value – The computerised rule-based system is easy to use and leads to a significant reduction in the time taken to generate an accurate functional specification. In addition, it provides a useful way of generating overall insights and communicating an e-business requirements picture at a management summary level.

Keywords Modelling, Electronic commerce, Business analysis

Paper type Research paper

Introduction

The concept represented by the term "e-business" has emerged as a central component of information technology planning during the last ten years. Typically it is argued (Cox, 1999, p. 168) that e-business represents modern thinking on supply chain management by providing "opportunities to fundamentally transform existing supply chains" through the erosion of the "middle men" (disintermediation) and the speeding up of the information linkage between ultimate customers and all stages of the supply chain, thereby providing "opportunities to eliminate many aspects of waste". By using internet-based information transfer, supply webs will replace the traditional linear movement of information within supply chains, thereby facilitating a more interactive approach to supply chain partnering (Kehoe and Boughton, 2001).

Also, e-business has been associated (Ritchie and Brindley, 2000, 2002) with the concept of the "amorphous supply chain". The premise is that the linear supply chain relationship model, which dominates most sectors, will be replaced by an "amorphous"'

Journal of Manufacturing Technology Management
Vol. 18 No. 6, 2007
pp. 659-677

1741-038X
DOI 10.1108/17410380710763840

supply chain relationship model, where one can build, change and reformulate flexible partnerships at speed, because the internet facilitates the potential for effective collaboration.

The following definition of e-business is characteristic: "The use of systems and open communication channels for information exchange, commercial transactions and knowledge sharing between organisations" (Croom, 2005, p. 55).

From the above, it is not surprising that the argument is quoted (Van Hooft and Stegwee, 2001) that the "e" – will soon be dropped and that e-business will be business as it comes to be generally understood. The clear impression so gained is one of a marketing-driven domain, and the danger of is that the "e-business" concept becomes an over-hyped marketing "solution in search of a problem" used by salesmen in their never-ending search to persuade prospects to buy information technology products. Therefore, while many organisations are interested in the e-business concept, getting to industrially validated real requirements is not easy.

The motivation of the research described in this paper is that there is a real need to provide objective assistance to organisations faced with making investment decisions in a domain that is currently very solution led (and hence marketing led), based on the advances made possible by software in general and the internet in particular. The hypothesis of the research described in this paper is that it is possible to produce a systematic process and a model that defines usefully the probable e-business requirements of an organisation based on objective criteria. This paper describes the creation of such a model, based on a model structure and approach proven in prior research. It describes how it was possible to produce a generic model, based on characteristics and concerns, which can generate a functional specification to a useful level of detail, at a useful level of accuracy. It also describes how the accuracy and usefulness of the model was evaluated.

Sources for the model

Although conceptual models are common, there is relatively little publicly available literature that describes the generation of system requirements at a sufficient level of detail to be useful for real organisations. We are aware of only one example that addresses the topic at the level of detail that we require, and this is the work of Howard *et al.* (1998).

This research demonstrated that it was possible to predict the detailed functional requirements of a manufacturing system for an industrial enterprise, based on objective factual characteristics (such as volume parameters and product characteristics) and management concerns. It was demonstrated that by processing such concerns through a reference model, one could produce a functional specification at a level sufficient to become the basis of an invitation to tender for potential software suppliers. Moreover, in one case it was demonstrated that the specification produced was more complete than that produced by a project team using a more traditional method of requirements specification (department requirements bidding by committee).

Figure 1 shows the concept. The process starts with the collection of the company characteristics and management concerns by an interview process with an appropriate company person. These are matched against the reference model that defines the

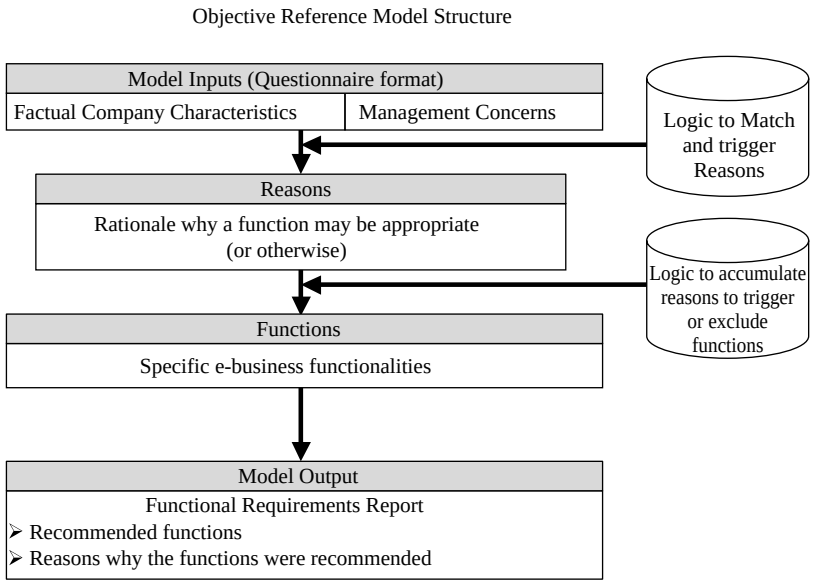

Figure 1.
The objective reference model structure

complete set of functions available and contains logic to decide those situations where a particular function should be relevant (or otherwise).

From this matching a list of recommended functions for the enterprise is produced, and presented alongside a trace of how and why particular selections were made.

Our e-business model

The e-business model was intended to use the same structure. The e-business functions are defined. Reasons why such functions may be appropriate or inappropriate are postulated. Company characteristics and management concerns that cause such reasons to be activated or not identified. In principle, company characteristics are intended to be as objective and factual as possible (such as number of items despatched per year). The value of the model lies in its ability to predict from these facts what is likely to be significant and what is not. For example, there is no point in asking whether a customer wants EDI invoices (or whatever) and then saying that this is a reason for specifying EDI invoices as a relevant function – this is obvious and of no use. The model needs to predict that a customer is likely to require EDI invoices – even if he has not thought of it.

The concept of management concerns may at first sight seem anomalous in a model purporting to be objective. The importance of the concerns is that they address the issue of how internal attitudes or customer/supplier behaviour can make or break the relevance of certain functionalities irrespective of the objective relevance or otherwise of these said functions. In the model, concerns tended to have one of two effects:

(1) they represent a problem that ought to be a motive for interest in an e-business function (e.g. excessive clerical activity); and

(2) they represent a problem that would tend to prevent an e-business function from being useful (e.g. our suppliers cannot cope with our e-business-oriented communication with them).

Howard *et al.* (1998) focused their research on the established domain of manufacturing control system internals and demonstrated that results of practical use could be achieved. It proved possible to get below the level of broad generalisations and produce detailed advice and guidance that was practically useful for real businesses with real problems.

The challenge for the research described in the current paper was to assess whether Howard *et al.*'s approach could be adapted and extended to create a similarly structured model in the far less established domain of e-business.

Research methodology considerations

In broad terms the research consisted broadly of the following stages:

- a review of available e-business related literature and expertise;
- the development of a model based on this literature and expertise; and
- the testing and stepwise refining of the model using a selection of case studies leading to the production of an "approved" model.

Support for this type of reference-based approach is common, for example Bititci (1995), Stirling *et al.* (2002), and Jennings (1997), in areas related to the domain of e-business. Jennings in particular recommends the construction of a systems model as soon as there is sufficient information (possibly during the prior research, certainly after the first visit) with the model being further developed iteratively throughout the case research process.

The question arose as to whether our methodology qualifies as "action research". There are some definitions of action research that are drawn so widely that any research seems to qualify if it involves practical problem solving that has theoretical relevance (Chiasson and Dexter, 2001; Mumford, 2001). It seemed to the authors, however, that the weight of literature (Altricher *et al.*, 2002; Gilmore and Smith, 1996; Gummesson, 2003; Näslund, 2002; O'Leary *et al.*, 2004; Westbrook, 1995) reserves the term "action research" for situations when researchers assume the role of change agents of the processes and events they are simultaneously studying. This does not fit what was done here.

According to Yin (1994), the quality of a research project and its case study design can be tested in four areas. Table I presents the results of such an evaluation indicating the main research tactics used to meet these tests.

Research process

The research method adopted consists of the following phases shown in Figure 2, and described in detail below.

Literature review

In the introduction we established what typically the e-business concept typically meant in the literature. The twin themes seem to be:

(1) the integration of systems with those of customers and suppliers (the "supply chain"); and

(2) the use of the internet to transact business within this supply chain.

Table I. Evaluation of research design

Criteria	Definition	Main research tactics used
Construct validity	Establishing correct operational measures for the concepts being studied	The use of triangulation principles using multiple sources of evidence to ensure that a good preliminary definition of e-business scope for manufacturing companies: • Literature • E-business marketplace material, • A survey of current and planned e-business activity
Internal validity	Establishing causal relationships between research variables (certain conditions are shown to lead to other conditions)	The construction of an e-business characteristic/reason/function model creates the basic cause-effect links. From a set of input characteristics a set of e-business functions (i.e. answers) are generated. These are associated with a rationale that justifies the answers given by the model. Analysis of model evolution demonstrates declining rate of change over multiple case studies
External validity	Establishing the domain to which a study's findings can be generalised	Demonstrated by repeated case studies, where the results are discussed with key participants. Taken overall, over a number of case studies, the justification of the model is based on the results being judged "reasonable" by a group representing a cross-section of knowledgeable persons capable of assessing the true-e-business requirements of their organisation. Analysis of model change demonstrates declining rate of change over multiple case studies
Reliability	Demonstrating that the operations of a given case can be repeated with the same results	A standard questionnaire is used for each case study and the model generates the same results automatically on each occasion from the same inputs

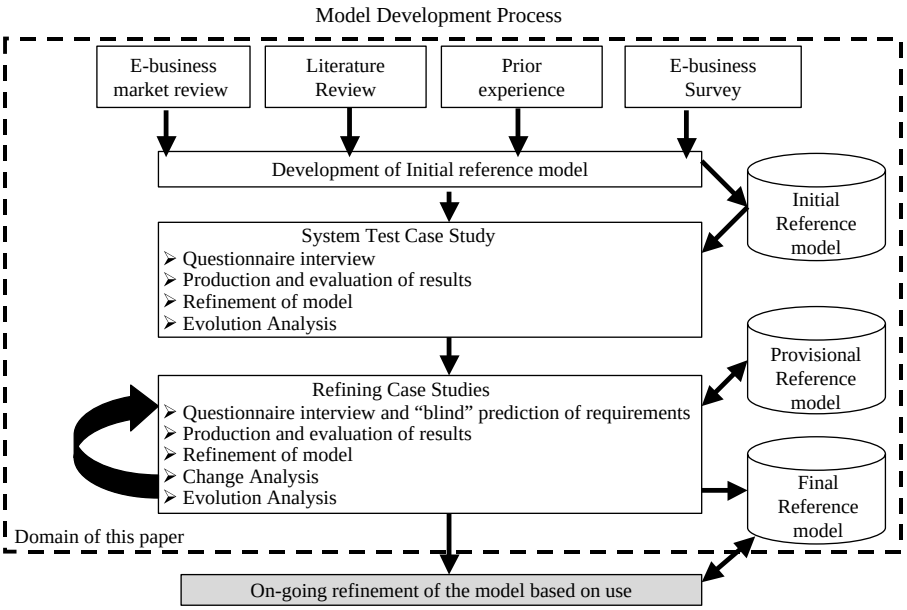

Figure 2.
Research structure

In looking to the literature for assistance in creating the initial reference model, the interrelationship with enterprise resource planning (ERP) systems seemed of importance.

Soliman and Youssef (2001) see two information technology components tools for achieving sustainable competitive advantage. These are:

(1) internet-based e-business; and

(2) enterprise integration using ERP systems.

The distinction made here is between inter-organisation integration, which is the domain of e-business; and intra-organisation integration, itself the domain of what is generally termed "ERP systems".

A typical definition of ERP systems (Payne, 2002) describes an approach to the provision of business support software that enables companies to combine the computer systems of different areas of the business production, sales, marketing, finance, human resources, etc. and run them off a single database. Various definitions of the functions provided by ERP system are available. Those provided by Rondeau and Litteral (2001) seem typical.

This dualism (inter = e-business; intra = ERP) represents a different view from some others (Pant and Ravichandran, 2001; Croom, 2005), which would imply that ERP systems are a component of the all-encompassing e-business whole. Alternatively there is a new view of ERP, referred to as "ERP II" (Møller, 2005) which would have the ERP umbrella concept taking over what we currently consider as "e-business".

Either way it would seem that we are justified in regarding e-business and ERP systems as inextricably interlinked. Indeed, it is recognised (Biehl, 2005; Bendoly and

Schoenherr, 2005) that investment in the ERP domain is an important factor in the achievement of benefit from e-business initiatives.

Review of e-business market place material

For a marketing driven domain, a significant input to the model was necessarily the functions that the market place is trying to sell under the e-business banner. The e-business functional specifications provided by two major ERP vendors (SAP, www.sap.comand the Oracle Corporation, www.oracle.com) were therefore reviewed.

In addition, material produced by organisations that are involved in influencing, guiding or selling products or services into organisations embarked upon e-business initiatives was reviewed:

- representatives of the business community attempting to provide encouragement to those interested in moving forward with e-business (The CBI (2002) "Reality bites" UK Council for Electronic Business – Electronic Business Assessment Tool, www.ukceb.org);
- the supply-chain operations reference model, attempting to provide models and structures in areas relating to e-business (Institute for Systems Research Project ENSE-621, www.isr.umd.edu);
- an example of an e-business exchange vendor developers interested in marketing their products (Covisint, www.covisint.com); and
- the ODETTE standards organisation active in the e-business domain (ODETTE – the Organisation for Date Exchange and Tele Transmission in Europe, www.odette.org).

Prior experience

Some of the genuine subject knowledge to be exploited (Kotnour, 2001; Stirling *et al.*, 2002) resides with one of the researchers, who has worked in the ERP and related fields for some 20 years. This prior experience was used primarily to direct attention to the most likely sources of good information and in suggesting rationales to link these e-business functions to possible characteristics.

Survey of e-business activity

As a fourth source of input, it was decided to find out what e-business activity is actually occurring in real life at the detail level in organisations relevant to our research. An e-business questionnaire was designed to capture four basic types of information:

(1) the e-business activity currently being undertaken or envisaged;

(2) levels of satisfaction with what is being done (or not done);

(3) concerns that may be inhibiting e-business; and

(4) benefits that have been achieved with e-business.

The survey questionnaire was sent to a mailing list containing every manufacturing company of any size in the UK west midlands. A total of 53 responses were obtained.

The survey results supported the view that, in practical terms, e-business represents incremental improvements rather than a revolution in the conducting of business.

There was also support for the initial proposition that there is a need for more unbiased advice and support to organisations contemplating or embarking on e-business initiatives. Useful input was provided into the e-business functional model especially in the area of likely relevant management concerns.

Development of e-business functional model

From the various sources, it was possible to construct a comprehensive identification of the detailed functionalities covered by the general "e-business" label. These functions were clustered into a number of functional domains. Within these domains, the functions were structured into three levels, the structure following the general consensus exemplified by McCormack and Kasper (2002):

(1) *Informational functions.* Envisaged as the one way accessing of information (or the provision of information for other parties to access).

(2) *Transactional functions.* Envisaged as the one way routine transmission of information, ideally in an automated form, linked to the specific business process that generated that information.

(3) *Control and co-ordination functions.* Envisaged as (often) two-way processes, which prepare for, manage, or deal with issues arising from the operation of the business processes associated with, or made possible by, the other e-commerce functions. In many situations this will describe those processes involving collaborative interaction between partners.

Table II illustrates the function domains that the model encompasses and the number of functions of each type within each of these domains in the final version of the model. Table III illustrates the functions within one functional domain.

A preliminary rationale (i.e. a set of reasons) was produced in order to link these e-business functions to possible characteristics, thus allowing a preliminary list of

		Number of functions		
		Information	Transaction	Control
Demand side	Product development and pre-production	5	7	6
	Demand management	10	18	7
	Supply chain planning	3	3	5
	Outbound logistics	4	15	4
	Customer accounting	3	8	6
	Service	4	8	4
Supply side	Product development and pre-production	4	7	6
	Supply chain planning	3	3	6
	Purchasing and procurement	7	17	6
	Inbound logistics	4	11	4
	Manufacturing	3	7	3
	Supplier accounting	2	7	3
	Maintenance	3	5	7
	General finance	1	3	3
	Administration	4	3	4
	Total	60	122	74

Table II.
E-business functional domains

Supply chain planning	
Information functions	Access to customers planning data
	Provision of capacity information for customers
	Provision of current forecasts for the customer
Transactional functions	Status of vendor or third party managed inventory
	Transmission of production schedules to customers
	Reception/integration of customer forecasts
Control and co-ordination functions	Comparison of demand with constrained supply plan
	Collaboration on forecast exceptions
	Establishment of parameters for partner managed inventory
	Notifications and planning alerts from customers
	Collaborative performance data collection and presentation

Table III.
Illustration of the functions in one functional domain

characteristics and concerns to be produced. Together, this functional definition, reasons, and characteristics were combined into a model containing the logic that linked them all together. The model logic was designed to both reflect intrinsic relevance (e.g. if a company produces many invoices, then electronic invoicing may be indicated) and company size (e.g. "Function X is theoretically of value to a company with these characteristics but the size of the company probably makes it an impractical or non-cost-effective to consider").

An example of one function, its description, the potential reasons for, related characteristics and relevant management concerns is given in Table IV.

Function title	Collaboration on forecast exceptions
Function description	This is a refinement of the process of sending exception messages between you and the customer. The idea is that you both collaborate on exceptions more interactively, enabling problems with the model of the supply network and the production plans to be solved more quickly. This type of collaboration uses Internet-based facilities (typically using a supply chain exchange) to share data more effectively and turn around exception situations more frequently
Reasons for the relevance of this function	The planning/master scheduling task is of significant size
	Forecasts are necessary to plan production
	Forecasts are potentially reliable enough to be useful
	The market is susceptible to abnormal demand patterns (i.e. spiky demand is common)
	Scheduling and promising of demand is dictated by manufacturing schedules reflecting capacity utilisation of key resources
Characteristics that affect this function	Total number of master scheduled items (i.e. total number of items for which MPS is carried out)
	The average number of customers delivered to per week
	Percentage of products where demand can be considered as seasonal (peak in demand twice the value of the trough)

(*continued*)

Table IV.
Illustration of the model components affecting one function

	Period of time for which the forecasts are accurate enough to base the manufacturing planning on (as a percentage of customer demanded lead time)
	Percentage of production that can be considered sell-from-stock (i.e. forecast driven, order point driven or similar)
	Percentage of production that is not started until the customer orders are received (i.e. make-to-order)
	Percentage of production that is geared towards fashion products (total market for the products can change unpredictably)
	The average percentage of the master schedule changed within the lead-time horizon due to demand changes
	Percentage of customers who are loyal in the medium term (i.e. do not shift to other suppliers within medium-term planning horizon)
	Percentage of production where planning is significantly capacity constrained (including labour)
	Average number of spot orders received per week (as opposed to schedule call-offs)
Concerns capable of impacting this function	We cannot rely on our customer's forecasts
	Customer lead time expectations are a significant management issue for us
	We currently consider that we have an insufficient forward view of demand
	Our customers dictate requirements without concern for the problems they cause
	Customers fail to communicate requirements clearly or respond effectively to queries
	We incur expense because of our customer's non-adherence to industry standards
	We are constrained by the e-business capabilities of our customers
	Our relationship with the customer depends on a personal relationship
	We have poor data accuracy
	IT investments generally fail to achieve their objectives because we do not use the software well
	We usually find that the costs of introducing e-business functions cannot be justified in relation to the benefits obtained
	We do not have the management determination to exploit e-business

Table IV.

Testing and refinement of the model

The testing and refinement of the model is the crucial stage (Stirling *et al.*, 2002). The major activity of this research was the recursive development, testing and refinement of the preliminary model so that a working version suitable for practical application in a manufacturing organisation can be produced. This process of testing and refinement must of necessity consist of two logical phases:

- Phase one was regarded as part of the model development process. Running the model for the first case study was regarded as a "system test" in order to prove the process and to get as many technical errors and obvious mistakes out of the model as possible. This case study is referred to as the "system test" case study.

- Phase two is oriented towards refining the model. This is done by a process of running the model for a number of case study instances. These are referred to as the "refining" case studies.

In both of these phases the process was fundamentally the same. The characteristics questionnaire was completed, and the model run. The predictions of the model were assessed for reasonability in discussion with an appropriate person in the organisation concerned. *Post-hoc* rationalisation of the reasons for discrepancy is then undertaken, and the model is corrected and/or further developed as required.

Each individual case study was conducted along the following structured lines:

- The case study contact (someone who is authoritative on the case study organisation's e-business current activity and future plans) was interviewed. At this interview the input questionnaire was completed interactively.
- The model was processed and an e-business functional report produced.
- The functional report was then worked through with the interviewee. The views of the interviewee were not taken uncritically, but areas of disagreement were exposed and explained in terms of the logic of the model. An agreement was reached as to whether the correct functions were being recommended or not recommended, and also whether there were functions thought to be relevant, missing from the report.
- Areas where the model seemed to be incorrect were studied and any flaws or inadequacies in the reasoning exposed, and corrected. If the reasoning was complete, but the answer still not "correct" (this was relatively rare), then such discrepancies had to be accepted as a reasonable difference of opinion.

The case studies

Characteristics of the case studies

The characteristics of the eight case studies are described in Table V. The case studies were to some extent self selecting in the sense that they were organisations that had a genuine interest in the topic. The location of the case studies (West Midlands) explains the heavy bias to automotive related organisations, the automotive sector demonstrating both activity and interest in the e-business domain.

Phase one – the system test of the model

The first case study, the "system test" was designed to prove the basic concept and was undertaken with a manufacturing organisation active in the e-business. The results were evaluated from a functional standpoint and certain improvements to the process were identified and implemented (for example clarifying the meanings of characteristics). Table VI illustrates the size of the model at the end of its system test.

Phase two – model refinement

The further seven "refining" case studies were allocated to the model refinement phase. Although this was a small number in statistical terms, it was possible to visit every functional area and to reflect on the model the impact of company size. Inevitably some functional areas were subject to more examination than others.

The purpose of the case studies was to focus attention on the areas where the model gave unexpected answers, and thus to animate the further study of the

Case study	Description	Size
1	Case study one, the "system test" case study, was an automotive company manufacturing high precision, safety critical components and experiencing significant e-business pressures in the automotive sector	Medium/large
2	Case study two was one major business unit of a major multinational involved in the supply of heavy agricultural machinery configured for the customer with complex dealer networks	Very large
3	Case study three was a small West Midlands company making metal components specifically developed for the customer for a variety of engineering applications	Small
4	Case study four was a sales company with no manufacturing offering a wide range of product variants for the automotive industry including both original equipment and for the aftermarket	Large
5	Case study five was a company producing very low technology products, with minimal manufacturing, but still with significant e-business pressures its supply chain, primarily from its customers	Medium
6	Case study six was a major automotive multinational component manufacturer, highly coherent both in terms of the products sold and the manufacturing processes undertaken	Very large
7	Case study seven was a small manufacturer of mechanical handling equipment where we could study a situation where engineer and configure to order is normal, and the company size too small for IT sophistication	Small
8	Case study eight was a UK division of a multinational selling electrical equipment, and provided the opportunity to study a genuinely networked supply chain	Large

Table V.
Case study characteristics

Possible e-business functions	254
Reasons	179
Characteristics	113
Concerns	63
Detailed model logic lines	2,226

Table VI.
Model statistics at the end of the system test phase

model reasoning. It was never the purpose to force the model to give "correct" answers; the model was only changed if it became clear that the model reasoning could be improved. The potential problem of one case study reversing the "corrections" and hence the validity of a previous case study was recognised and was controlled by analysing the evolution of the model (see below). Once corrected, the model was rerun and a report produced for the benefit of the case study participant organisation.

Table VII illustrates the size of the model at the end of the model refinement phase and illustrates its expansion during this phase.

It can be seen from this that the result of the "refining" process was not significantly to expand the model. The original functional specification as to what was meant by "e-business" therefore stood up rather well to scrutiny. What was significant about the "refining" phase was in fact in the expansion of the reasoning. The logic that leads from characteristics to functions was made more complex as a result of studying the model in practice. This was the expected result and served to justify the model development methodology.

Analysis of the model evolution

One of the key controls on the validity of our case study methodology was the analysis of the evolution of the model as the case studies progressed. The purpose of analysing model evolution was to:

- verify the extent to which the model was giving reasonable results;
- that as the case studies progressed, the amount of change decreased thus demonstrating that the model was moving towards stability; and
- that as the model is refined by each case study, the results of previous case studies are not significantly degraded.

Two types of analysis were attempted:

(1) *Analysis of changes.* What changes were made and for what reason as a result of each case study.

(2) *Analysis of model stability.* How the results produced by the model for the system test case study changed as a result of the feedback from subsequent case studies.

Change analysis

All changes made to the model were recorded. These changes were widely different in respect of both the size of the change itself and the wideness of effect in the model.

Against each change was recorded the type of change and the functional domain that stimulated the change. These changes were analysed by type of change (Table VIII) and by functional domain (Table IX) split between:

- the system test case study; and
- the refining case studies (using an averaged out figure).

	Number	Expansion (percentage)
Possible e-business functions	256	1
Reasons	207	16
Characteristics	122	8
Concerns	63	0
Detailed model logic lines	2,788	25

Table VII.
Model statistics at the end of the model refinement phase

Table VIII.
Changes by type of change

By type of change	System test case study Number	System test case study Percentage	Average for the refining case studies Number	Average for the refining case studies Percentage
Model expansion – new characteristic, reasons, functions	49	46	6.6	42
Model simplification – removal of reasons, etc.	14	13	1.9	12
Adjustments to triggering thresholds	20	19	2.0	13
Clarifications, adjustments and rationalisations	18	17	3.7	24
Questionnaire answered wrongly	0	0	0.6	4
Errors in the model	5	5	0.6	4
Model logic improvement	0	0	0.3	2
Total	106		15.6	

Table IX.
Changes by functional domain

By functional domain		System test case study Number	System test case study Percentage	Average for the refining case studies Number	Average for the refining case studies Percentage
Demand side	Product development and pre-production	4	4	2.1	14
	Demand management	14	13	4.0	26
	Supply chain planning	2	2	0.7	5
	Outbound logistics	6	6	1.1	7
	Customer accounting	12	11	0.1	1
	Service	0	0	0.4	3
Supply side	Product development and pre-production	20	19	0.4	3
	Supply chain planning	10	9	0.4	3
	Purchasing and procurement	9	8	2.9	18
	Inbound logistics	11	10	0.6	4
	Manufacturing	1	1	0.7	5
	Supplier accounting	8	8	0.1	1
	Maintenance	6	6	0.6	4
	General finance	0	0	0.6	4
	Administration	2	2	0.4	3
	Cross application	1	1	0.3	2
Total		106		15.6	

Taking the average over the "refining" case studies, it is clear that the changes during these case studies were significantly less than those made as a result of the "system test" case study. This gave us confidence that the model was moving towards stability and (more importantly!) providing reasonable results.

Although overall, the quantities of changes were significantly less during the refining phase than during the system test phase, the types of change showed in similar proportions.

When we look at the changes by functional domain we see a number of "hotspots". These can probably be explained by virtue of the fact that some functional domains are more active, relevant (and perhaps fashionable) than others. Demand management alone

was a hotspot in both the development and the testing case studies. With this exception, the hotspots were different. Although too much should not be read into this, it was considered as reassuring us that (taking all the case studies together) the major functional domains had been subject to a searching examination.

Analysis of model stability

We were interested to verify that later case studies should not cause a model (and therefore the answers) for an earlier case study to change subsequently to a significant extent.

In the case of the system test case study, we had the opportunity to test how the model, established by the initial system test case study, evolved as a result of the refining case studies. Two evolutions were therefore considered:

(1) the results provided by the model as it was at the beginning of the system test phase (before) versus the results provided by the model as it was at the end of the system test phase (after); and

(2) the results provided by the model as it was at the end of the system test phase (before) versus the results provided by the model as it was at the end of the refining phase (after).

For the purpose of this analysis we looked at the number of e-business functions triggered or not for the "system test" case study. A triggered function was scored as 1, a non-triggered function was scored as 0, and a situation where there were contradictory indications was scored 0.5.

Table X shows the evolution of the system test case study both during its own process and then subsequently during the other seven refining case studies. The function changes are analysed between reductions (functions triggered before the case study analysis process but not afterwards) and increases (functions triggered after the case study analysis process but not before).

As can be seen by the analysis, there was little difference between the system test case study when assessed after the system test phase and that when assessed after the refining phase. This demonstrates that the changes made as a result of the further case studies were not invalidating the results of the first case study. It therefore gave us the confidence that our model refinement method was correct.

Conclusions

The main objective of this research was to provide a method whereby organisations interested in the e-business concept can understand their requirements with relatively little time and effort. Although there are "softer" inputs to a requirements definition process (e.g. special circumstances, politics), our objective was to create a model good enough to be a useful animator and guide for such a process.

This approach in effect allows the analysis and presentation of a detailed functional specification of requirements within a day. At the present time we know of no other approach that is capable of producing such a model to the same level of detail.

The primary purpose of the research described in this paper is to produce a model capable of giving useful advice at the detailed level rather than merely producing superficial diagrams. However, as a by-product of the case studies, it proved possible to create overall e-business profiles of each organisation, a profile that was used in a

Table X.
Analysis of the evolution of the system test case study

	Total functions at end of phase	Functions triggered		Reductions		Increases	
		Model "after"	Model "before"	No.	Percentage	No.	Percentage
Evolution of system test case study during system test phase	254	109	97	36	14	49	19
Evolution of system test case study during refining phase	256	107.5	109	3	1	0	0

management summary of the produced report and was invaluable for management level communication.

The model was created initially based on theoretical considerations and the strategy was to refine and improve it using a multiple case study approach. We have demonstrated that such a case study process has produced a model that gives sound results and tends to improve with usage. We therefore feel that we have validated the basic research method that we have adopted.

A system of this nature will improve as it is used in an increasing number of new situations not previously involved in the development of the model and the feedback from the companies is evaluated.

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Further reading

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About the authors

John Dilworth is a self employed consultant and combines his business activities with part time research at Aston University, primarily focussed on the development of techniques for objectively determining the e-business requirements of an organisation. He has 30 years of experience in the evaluation, operation, development and implementation of computer-based systems. He has extensive experience in manufacturing systems consultancy, project management and implementation support in projects addressing the logistics and

manufacturing requirements of a wide range of companies in the UK and Europe. He has developed a special expertise in techniques to assist manufacturing companies on the identification, planning, justification and choice of computer systems and in the critical factors that govern their success. He has an MA in natural sciences. John Dilworth is the corresponding author and can be contacted at: dilworaj@aston.ac.uk

A.K. Kochhar is Head of the School of Engineering and Applied Science, and Professor of Manufacturing Systems and Management at Aston University. Prior to taking up his current appointment, he was Head of the Department of Mechanical Engineering and Lucas Professor of Manufacturing Systems Engineering at the University of Manchester Institute of Science and Technology. His main research interests include performance measurement and benchmarking; competitive manufacturing; design, planning and control of manufacturing systems; and manufacturing innovation. He has worked with British Aerospace, Lucas Industries, GKN, Thorn-EMI Group, ITT, the 600 Group, Standard Telephones and Cables, Manufacturing Products and Services, Open Business Solutions, Robinson Nugent and a number of small- to medium-sized enterprises. He is a Fellow of the Royal Academy of Engineering, the Institution of Mechanical Engineers, and the Institution of Electrical Engineers. He has published widely, including four books and editor of three sets of conference proceedings. E-mail: a.k.kochhar@aston.ac.uk