BUSINESS PROCESS RE-ENGINEERING AND ORGANISATIONAL CHANGE: EVALUATION OF IMPLEMENTATION STRATEGIES

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Dedication

This thesis is dedicated to my partner for life, Ioanni Nikolaou, for his love, encouragement and support

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From the bottom of my heart, a big thanks to all of you.

Declaration

This thesis contains references to material by the author, which have previously been published in conference papers, and have been submitted for review to journals. These are:

Rezgui Y, Cooper G, Vakola M and Tracey A, Computer Support for Collaborative document Production and Management, CIB W78 Conference "The Life-cycle of IT Innovations in Construction - Technology Transfer From Research to Practice", Stockholm, June 1998.

Rezgui Y, Cooper G, Vakola M and Tracey A, "Advanced Document Management Solutions for the Construction Industry: the CONDOR approach, presented in the Conference in Concurrent Engineering", 5th ISPE International Conference on Concurrent Engineering, Tokyo, July 1998.

Vakola M., Rezgui Y., Wood-Harper T., "Business Process Re-engineering and Construction Industry: The Condor Approach" presented at the 4th International Conference on ISO 9000 & TQM, Hong Kong Baptist University, Hong Kong, April 1999

Vakola M., Rezgui Y., "Evaluation of the implementation of a business process re-engineering strategy devised by quantitative and qualitative findings in three European construction companies" presented at the international conference of organisational psychology, Helsinki, May 1999

Rezgui, Y., Vakola, M. and Cooper, G. "A Proposed Approach to Document Management Practices Redesign in the Construction Industry", submitted to the Journal of Construction Management and Economics.

Vakola M, Rezgui Y, Mitev N, Thompson J, "D3100 Business Process Re-engineering Strategy", CONDOR ESPRIT 23105 Deliverable, June, 1998.

External examiners

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Abstract

This thesis is based on research carried out within the CONDOR project funded under the European ESPRIT programme, which is a partnership between English, French, and Swedish construction companies. The thesis aims at presenting empirical evidence and discussion that moves toward a theory of successful implementation of change initiatives such as business process re-engineering trying to identify its main components. The thesis challenges the concept of business process re-engineering trying to add to the body of knowledge in this area through the development of a new business process re-engineering methodology applied and evaluated in the three case studies which were participated in the research.

The research methodology used is a combination of quantitative and qualitative research methods (triangulation technique). A major element of the thesis is the empirical work carried out, in which the researcher was actively involved using the new business process re-engineering methodology.

The analysis of both qualitative and quantitative results showed that the basis of a successful business process re-engineering should concern the development of some organisational characteristics, which would prepare the organisation for a more holistic form of organisational change.

Finally, the thesis draws together the different problems and questions that arise in order to develop a business process re-engineering strategy, based upon the literature and empirical findings, in order to improve organisational effectiveness and help the organisations to survive in a continuously changing environment

Chapter 1
Introduction

This chapter gives an introduction to the thesis presenting the scope of the research, its aims and objectives, its background and context and the researcher's background. This general overview of the context of the thesis will act as a reference point for the following chapters

1.1 The scope of the research

Global competition, economic pressures and the potential offered by the emerging technologies are pushing firms to fundamentally change their way of operating and rethink their business processes. Many companies have agreed that effective business process re-engineering (BPR) is one effective way of gaining competitive advantage (Dale, 1994).

Despite the eight years in which this concept has been explored, there is little research support for its effectiveness beyond some contradictory results arising from the analysis of various companies which undertook change initiatives such as business process re-engineering (Kettinger and Grover, 1995). This is in part because no theory describing, analysing and predicting the impact of BPR and its relationship with organisational effectiveness has been presented to guide the progress of empirical results. Although during the eight years of exploration the concept of BPR has moved towards a 'softer' form taking into account human and organisational aspects, there is still a missing part which would enable us to predict the impact of a re-engineering process.

The aim of this thesis is to present empirical evidence and discussion that moves toward a theory of successful implementation of business process re-engineering, trying to identify its main components. The beginning of such a theory is based on both conceptual synthesis of observations from practice and from literature research.

The analysis of both qualitative and quantitative results showed that the basis of a successful business process re-engineering should concern the creation of an organisational environment supportive of change through evaluation and, therefore, organisational learning which facilitates the implementation of effective change management practice which leads to organisational effectiveness.

The empirical research of the current thesis is based on the analysis of three construction companies, forming the three case studies of the present thesis, which were part of a European project called CONDOR (technology and processes for integrated **CON**struction **DO**cumentation p**R**oduction and management). The aims and objectives of the project are presented in the following part and a description of the three participating companies can be found in chapter 6 (qualitative analysis and results) and in more details in chapter 7 (practical applications of the CONDOR BPR model).

1.2 Aims and objectives

The aim of this thesis is to discuss and clarify the concept of business process through the development of an appropriate BPR methodology, identify the organisational and human issues involved and examine the relationship between evaluation of business process re-engineering and organisational learning and innovation. The research objectives of the thesis are presented in detail along with evidence form literature review and empirical work which will justify the choice of the research objectives and stress the importance of the research described in chapter 3 (research questions).

This aim translates into the following objectives:

- Develop an appropriate BPR methodology that will support business process initiatives and enhance organisational effectiveness in the construction industry.
- Clarify the concept of business process re-engineering through the development of a BPR methodology and its implementation in three construction companies.

- Identify those organisational and human issues which have an impact on the successful implementation of a business process re-engineering implementation in a construction firm.
- Identify the impact of evaluation of implementation of business process re-engineering on the change process.
- Define the role of evaluation of implementation of a business process re-engineering initiative in organisational learning and innovation.

1.3 Background of the researcher

The background of the researcher is a combination of psychology and organisational psychology studies, program evaluation, business process re-engineering practice and understanding of information technology.

The researcher has been involved in two European projects, CONDOR and GEMISIS 2000 (Tassabehji, Vakola and Varey, 1998), throughout the thesis gaining knowledge and experience in business process re-engineering and program evaluation. Although these two projects were trying to achieve different objectives in different areas of application, the general aim is quite similar. They are both trying to implement and use information technology applications in order to improve existing business processes in the construction sector for the case in the CONDOR; and exploit the sociological, economic and technological benefits of these application in the case of GEMISIS 2000. The involvement in these two projects gave to the researcher the unique opportunity to conduct research using a combination of research methods in real life contexts, use the data from CONDOR in order to complete the current doctoral thesis and study and gain knowledge and skills in different areas such as program evaluation, business process re-engineering and change management.

1.4 Background and context of the research

The current thesis is based on research which took place within the CONDOR project. The participating companies of this project constitute the three case studies of the current thesis. A basic presentation of the project which includes a background description, along with an introduction to the aims and objectives is

given in the next section. It has to be noted here that the following part is based on information taken from the documentation of the CONDOR project (Rezgui, 1998).

1.5 Introduction to the CONDOR project

1.5.1 Identifying the need

The construction sector differs from other industries by the very nature of its processes and resulting products. The building process is fragmented, involving different partners, sitting at different locations, with varying levels of IT support for their business processes. The resulting output from these processes is one-of-a-kind product. Furthermore, the nature of the construction industry is such that virtual teams are often brought together for projects before being broken apart again on completion (Rezgui, 1998).

In the design and construction process diverse and complex information flows between actors. This information is mainly conveyed using documents. Despite the interest and the effort put by many leading companies into information and document management, the discipline is still in its infancy (Rezgui, 1998). Many researches have acknowledged the limitations of current approaches to managing the information relating to a project (Commission of the European Communities, 1997a).

Most of these limitations are due to various problems (Rezgui, 1998), including the following:

- A great deal of project information is stored on paper-based medium (drawing, written document, etc.). This information is frequently not structured and difficult to use, and also easy to lose or damage.
- The intent behind decisions leading to information is not recorded or documented. It is also very complex to keep track and trace the route of the thousands of *ad hoc* messages, phone calls, memos, and conversations that lead to information.

- People responsible for collecting and archiving project data may not necessarily understand the specific needs of actors who will use it, for example the actors involved in the maintenance of the building(s).
- The data is usually not managed while it is created but instead it is captured and archived at the end of the construction stage. People who have knowledge about the project are likely to have left for another project by this time - their input is not captured.
- Lessons learned are not organised well and are buried in details. It is difficult to compile and disseminate useful knowledge to other projects.

The documentation produced in a project needs, therefore, to be highly consistent in order to provide a reliable basis for actors to perform their design, construction and maintenance activities. Document management has become a crucial issue within modern construction companies. The various solutions proposed by some software vendors proved to be unsatisfactory, to a point where many leading construction organisations, with an advanced IT departments, have undertaken the development of their own tools and solutions to support the production and maintenance of project documents (Rezgui, 1998). Even though such proprietary tools provide many helpful facilities, including support for document storage, retrieval, versioning and approval, they do not handle any semantics of the information being processed and therefore remain limited in their support of the end-user.

In fact, construction project data and documentation (including full specification documents) constitute two fragmented information sectors where compatibility and interoperability are mostly needed. Moving these pseudo-sectors closer together to support construction project documentation as part of the life-cycle of the building product is becoming an actual and urgent topic for standard bodies and industry alike.

In order to pioneer a solution, a consortium which consisted of construction end-users (Kvaerner Construction, OTH and JMBygg), IT providing companies (Cap Gemini, Carasoft Software) and universities and research institutions (CSTB,

University of KTH and University of Salford) was set up. The consortium collaborated within the frame of the European (ESPRIT 23 105) CONDOR project.

1.5.2 Project aims and objectives

The objectives of the CONDOR project as they are described in CONDOR documentaiton (Rezgui, 1998) are as follows:

- Improve the co-ordination of design and construction activities between all project parties.
- Provide opportunities for new processes and new forms of project organisations to be used on construction projects.
- Demonstrate the potential to reduce time in every part of the construction process (planning, designing and production) by 20%.
- Improve document quality and consistency throughout the project.
- Increase accessibility of project information to all participants in the process, and allow small to medium sized enterprises to be more closely integrated into construction projects.
- Define the process changes required in order to realise the benefits of integrated document management.
- Identify human, organisational and cultural issues impacting on the adoption of integrated document management and propose ways of addressing these.
- Integrate document based ("black-box") and model based approaches to project information management.
- Provide a migration path and strategy for moving from document-based to model-based approaches.
- Integrate more closely document types and representation (e.g. text and drawing).
- Identify similarities and differences between the construction industry and other industries with a view to transferring the results to other application domains.
- Investigate the distribution of documents using different levels of network capability.
- Demonstrate the practical application of the proposed approach.
- Demonstrate the integrated use of existing standards for messaging, products

modelling, etc.

While the above objectives apply mainly to the project end-users, the universities and the research institution involved in CONDOR have defined the following objectives:

- Development of a highly generic CONDOR information management model which handles various issues including object versioning, actor's rights and responsibilities, and change notification.
- Development of techniques to define the semantic links across the various forms of document and model-based information.
- Gaining understanding of the organisational and cultural aspects of introducing the document production and management proposed approach, into small, medium sized and large industries and organisations.

1.6 The role of the researcher in the CONDOR project

The researcher has joined the CONDOR project in September 1997. She was involved in the project because of her expertise in managing human and organisational issues in change initiatives. The researcher was part of the CONDOR team responsible for the business process re-engineering work deliverable. The team of 're-engineers' consisted of people from various backgrounds and professions such as construction, information technology, process analysis, organisational psychology etc.

Researcher's main responsibility in the CONDOR project was to conduct research in business process re-engineering and facilitate its implementation within the three participating construction companies in order to meet the project's aims and objectives. The researcher has started her work in CONDOR by identifying, analysing and evaluating the existing BPR methodologies and models coming from academics and practitioners. Having identified their main weaknesses the researcher created the eight stage CONDOR BPR model presented in chapter 7 (Practical applications of CONDOR BPR methodology).

The researcher then focused on the identification of the change levers trying to identify the main human and organisational issues involved in this business process re-engineering initiative. Therefore, the researcher conducted quantitative and qualitative research within the three participating companies. The results of this effort were incorporated in the findings of the other 're-engineers' working in the same work deliverable but with different objectives such as process analysis, mapping of existing processes, developing CONDOR architecture etc. The researcher explained the rationale of the CONDOR BPR model and gave some guidelines regarding to its implementation to the representatives of each company to the CONDOR project.

She also monitored the whole process and presented the findings to the CONDOR meetings. Moreover, the researcher defined the role of evaluation in business process re-engineering and she developed appropriate evaluation criteria in order to measure the effectiveness and efficiency of the new methodology.

To summarise, the researcher developed the CONDOR BPR model, identified the major human and organisational issues involved, synthesised the findings of the team of 're-engineers', facilitated the implementation of the model, monitored the progress, presented the findings, developed evaluation criteria and facilitated the evaluation in order to meet the objectives of the CONDOR project.

1.7 Summary of Chapters

The thesis is structured into nine chapters. A summary of each chapter can be found in the following part

Chapter 1 gives an introduction to the thesis presenting the scope of the research, its aims and objectives, its background and context and the researcher's background. Also, this chapter introduces the CONDOR project on which the research of the current thesis is based. The aim of this chapter is to give a general

overview of the context of the thesis and its general aim, which will act as a reference point for the following chapters

Chapter 2 presents the theoretical context of the concepts tackled throughout the research. Moreover, the nature of business process re-engineering (BPR), a theoretical framework for (BPR), the role of information technology (IT) in BPR, the criticisms of these concepts and the importance of the business processes are discussed. This chapter aims at analysing the theoretical evidence coming from the existing literature, critically evaluate the current thinking in the field of business process re-engineering which will become the basis for the analysis of the empirical evidence which can be found in the following chapters. Moreover, this chapter explains the supporting concepts such as information technology, business strategy, organisational culture, and human resources management which are the critical success factors for a successful implementation of a business process re-engineering initiative. The literature review will be used as the theoretical background for the formulation of the research questions.

Chapter 3 presents the formulation of the research questions of the current thesis based on the literature review and on empirical evidence. The research questions are related to the development of a business process re-engineering methodology, to the identification of the organisational and human issues involved in the change process, and to the analysis of the relationship between evaluation of the implementation of a business process re-engineering strategy and organisational learning and innovation. Also, this chapter highlights the importance of the current research through the presentation and analysis of the research questions

Chapter 4 presents the theoretical background of research methods in order to justify the combination of quantitative and qualitative methods used in the current study known as triangulation technique. The qualitative methods are based on in-depth interviews with employees of the three participating construction companies and on the analysis of these participating companies which serve as case studies for the research purposes of the current thesis. The formulation of case studies is based on the documentation coming from the CONDOR project. The quantitative

methodology consists of the use of a questionnaire that the researcher designed and distributed to the employees of the three companies.

Chapter 5 analyses the results arising from the use of quantitative methodology. The statistical analysis is based on the statistical package for social sciences (SPSS). This chapter presents the quantitative results, which are used in order to answer the research questions of the current thesis. A copy of the questionnaire can be found in the Appendix I. The significance of these results will be analysed and discussed further in chapter 9 (conclusions and synthesis of results)

Chapter 6 presents and discusses the findings from the qualitative research. The researcher has conducted twenty interviews with the employees of two participating companies aiming at exploring the organisational and human requirements of a business process re-engineering initiative in a construction company. The importance of the findings will be explored further in chapter 9 (conclusions and synthesis of results).

Chapter 7 presents and analyses the practical applications of the proposed CONDOR BPR methodology. The literature review, the critiques of existing BPR methodologies and the empirical work which took place within CONDOR led to a formulation of a business process re-engineering methodology which was used in order to facilitate the change process and enhance organisational effectiveness.

Chapter 8 presents and discusses the evaluation of the implementation of the CONDOR business process re-engineering methodology in the three participating companies. According to the critique of existing BPR methodologies presented in chapter 7(practical applications of the CONDOR BPR model), the evaluation of implementation of re-engineering initiatives is often neglected as revealed in the literature review. Chapter 8 argues that evaluation is crucial for the change process highlighting important issues related to business performance improvement, organisational effectiveness and user acceptability.

Chapter 9 presents the synthesis of the results and discusses the quantitative and qualitative findings of the current thesis. Results from the analysis and

evaluation of the CONDOR business process re-engineering methodology are presented and discussed. The limitations of the study and directions for future research are also explored.

Chapter 2
Literature Review

This chapter presents the literature review of the theoretical concepts involved in the current study. It begins by defining and analysing the nature and role of business process re-engineering in the modern organisation. This is followed by a discussion of the organisational readiness for a business process re-engineering initiative, indicating the importance of several supporting concepts such as information technology, business strategy, organisational culture and human resources management. Finally, the criticisms and contradictions associated with the concept of business process re-engineering are presented.

2.1 Introduction

In this chapter the relevant literature in the area of business process re-engineering which constitutes the major theme of the current thesis is reviewed. The selection of the literature is based on the research themes and objectives outlined in the introductory chapter (chapter 1, introduction) and analysed in chapter 3 (research questions). The chapter aims not only to present and critically evaluate the business process re-engineering literature but also to provide links with chapter 7 (practical applications of the CONDOR business process re-engineering model) and chapter 8 (evaluation of implementation strategies), where more insights from literature can be found.

The chapter initially presents the business process re-engineering concept and its components, and continues by exploring the major concepts associated with the organisational use of the term. Given the scope of the present thesis and the context in which the CONDOR project took place, some of these concepts are more significant than others. Therefore, the researcher has chosen to give more emphasis to information technology, business strategy, organisational culture and human resources management. Following this, the criticisms and the contradictions of the use of business process re-engineering are discussed.

2.2 The nature of business process re-engineering

An increasing number of firms are applying business process re-engineering (BPR) to alter many age-old procedures, to reduce costs, and to improve competitiveness. Business process re-engineering sets out to make a step change improvement in competitiveness and then maintain and improve on that competitiveness. Why BPR? Because there is need for a company to have processes that minimise delays, eliminate errors, promote understanding and reduce excesses. These processes must be adaptable to the changing needs and provide the organisation with a competitive advantage.

In this context, Information Technology (IT) plays an important facilitating role. It is clear that IT has evolved from its traditional orientation of administrative support role toward a more strategic role within an organisation and more specifically within the construction industry. This is the focus of the CONDOR project: investigating a new model-based - as opposed to file - based - approach to document production and management, based on recent IT developments. This model-based approach, supported by information technology, can provide a powerful lever of change. It can not however produce the benefits alone. The processes within the organisation and within the building projects must change in order to adapt in the new environment.

The first principles and elements of business process re-engineering can be found in Taylorism (task optimisation) and the scientific management theory. Business Process Re-engineering has been formally defined by Hammer and Champy (1993) as the *"fundamental re-thinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed"*. Hammer and Champy (1993) have highlight four key words in this definition, which enable us to understand the character of BPR.

The first key word is 'fundamental' which means that re-engineering begins with "*no assumptions and no givens*", Hammer and Champy (1993). Fundamental

rethinking returns to basic questions and identifies which activities add value to the product or service being delivered. Having answered the 'fundamental' questions the next stage is to take 'radical' corrective action. Consequently, the second keyword is 'radical'. Organisations are encouraged radically to restructure their operations. Existing structures that are not compatible with the new vision should be dismantled. The expectation is that radical changes will be accompanied by 'dramatic' benefits, which is the third keyword. Thus, re-engineering is not about making marginal or incremental improvements but about major improvements in performance. The last keyword is 'processes' which is very important since all BPR activity is based on process change. BPR starts to envision new ways of working and organising business processes.

There are four points of interaction in this framework. The first point is related with the business processes and the second point is concerned with structures of the jobs and the people needed to fill them. The third point of interaction refers to the role of managers, the working relationships and the measurement systems and, finally, the fourth point is related with the employees' values and beliefs. Consequently, re-engineering a company's processes affects all aspects of that company. These four points are linked together and re-engineering involves the redesign/re-planning of each of the four points on an ongoing basis (Galliers, 1995). Hammer and Champy (1993) presented the Business System Diamond model, which indicates the changes that occur when a company re-engineers its business processes (figure.2.1).

More specifically, the first point is business processes, which affects structures and jobs. The ways in which work is performed determine the way people's jobs are organised. For example, the integrated processes give rise to multidimensional jobs and the best way of supporting such jobs is to organise the employees into teams. Consequently, different structures and jobs require people who have the abilities to adapt themselves in the new working conditions. This interaction changes the way that employees are recruited, evaluated and paid. The third point, which is the change of management and measurement systems, determines the fourth point, which is related with values and beliefs.

Management systems such as performance appraisal, personnel evaluation, remuneration systems etc, influence employees' values and beliefs. This leads back to business processes at the top of the diamond because employees' values and beliefs must support every BPR initiative. For example, a more advanced technological system can be successfully implemented only if the users believe that there is a need for this system and that the qualities it can offer are important for their jobs or for the organisation in general. Finally, in BPR activity alone is not sufficient to redesign processes. The links between the four points are very important and they have to fit together in order to successfully support the BPR strategy.

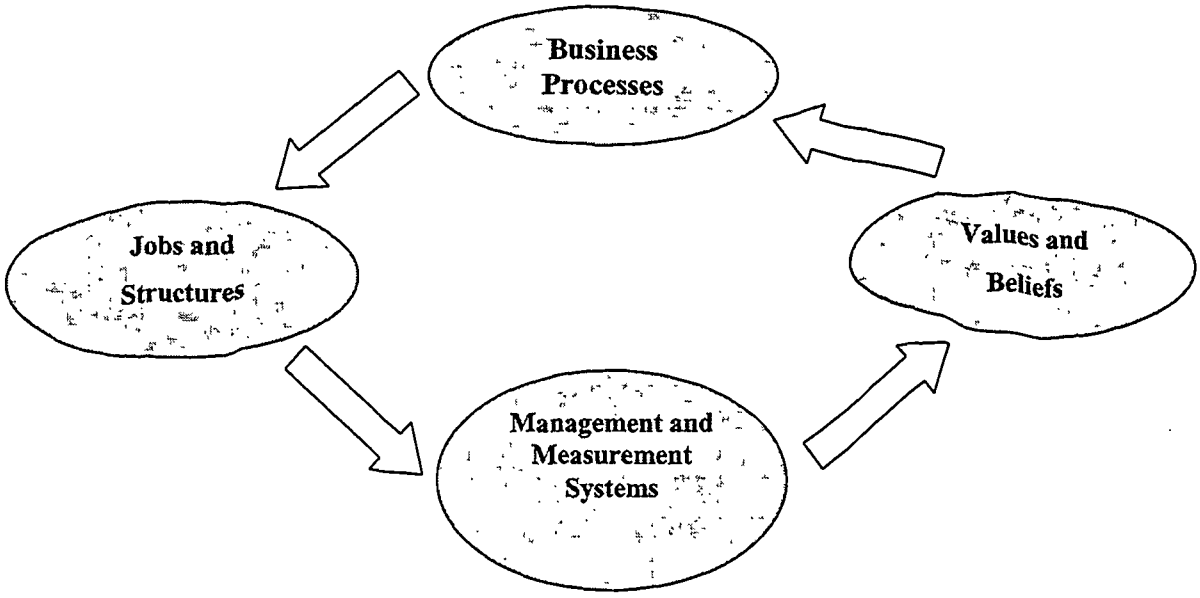


Figure 2.1: The Business System Diamond, Hammer and Champy, 1993.

Davenport (1993) offers a different perspective of the topic. Davenport refers to the term 'business process re-engineering' as 'process innovation' and business process redesign', which is an indicator of the plethora of BPR definitions, approaches and methodologies. Consequently, according to Davenport's business process redesign and later process innovation, an organisation is aiming at achieving major reductions in process cost or time, or major improvements in quality, flexibility, service levels, or other business objectives. The organisation is trying to achieve this goal through the use of innovation tools and work design which will lead to radical improvement of business process performance.

As a result, it is clear that BPR denotes organisational transformation. Bots and Sol (1988) distinguish three perspectives with respect to the design of organisations and their technical information structures (these perspectives can be used to better position the concept of business process re-engineering as shown in figure 2.2 below):

- the macro perspective, concentrating on the co-operation among different organisations and on supporting and enabling technical infrastructures
- the meso, perspective, concentrating on co-ordinating activities that take place within boundaries of an organisation and on supporting and enabling technical architectures
- the micro perspective, concentrating on the primary business processes that are performed at the work place level, typically by an individual or a small group, and on enabling and supporting work stations

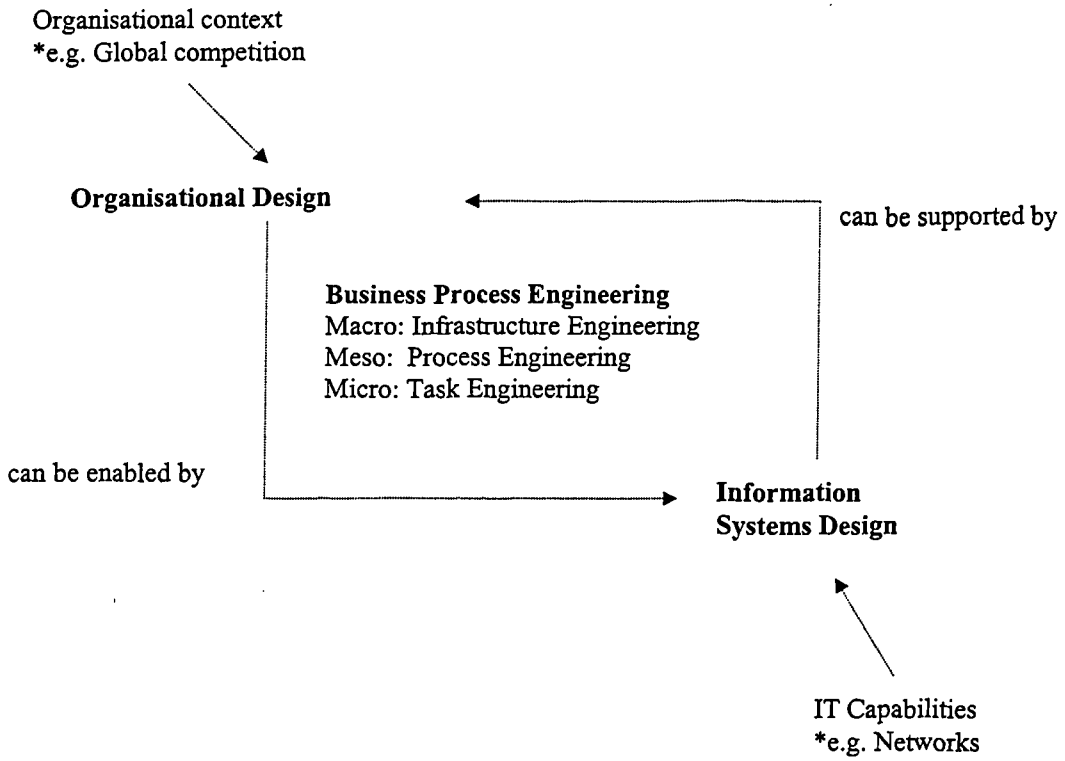


Figure 2.2: Positioning of Business Process Re-engineering, Bots and Sol, 1988

Depending on the perspective, three different forms of organisational transformation can be distinguished: infrastructure engineering (macro), which deals with strategic choices about partners, markets and products, process engineering (meso), which is based on the redesign of existing processes in order to support the successful implementation of strategic choices, and task engineering, which deals with job design (micro).

Subsequently, the most important impact of BPR may be observed on the competitive front of an organisation. Organisations recognise that the world is becoming a more competitive place and that incremental improvements are not enough. A successful redesign of business processes leads to improvements in time, quality and cost of products and services offered. Therefore, BPR enhances an organisation's ability to respond to market conditions and enables companies to differentiate themselves from their competitors. Consequently, the aim of BPR is not to keep up with the competition but to leap ahead of the competition (Coulson-Thomas, 1995).

Several factors encourage a more fundamental, integrated and better managed approach to planning and designing business activities and explain the current interest in BPR (Talwar, 1997):

- the globalisation of business - globalisation, deregulation and liberalisation of markets increases the competition
- economic pressures - the global recession is increasing unemployment and leading to greater price competition
- operational challenges - shareholders are looking to management to sustain profitability and competitiveness while the need for customer service, quality, speed and flexibility is increasing
- competitive learning - recognition that training, learning and re-skilling are powerful tools and critical success factors
- continuous change - recognition that change is an ongoing process and the successful management of change leads to competitiveness
- past management failures - a recognition that past management failures have left the organisations with inefficiencies and weaknesses

The growing interest in BPR has been noted in several recent information systems surveys in large organisations (Butler, 1994). CSC Index's survey of 407 North American and European companies showed that 70% of participant organisations were involved in BPR initiatives, while 14% were discussing the possibility of undertaking similar projects (Index Group, 1993). In their survey of 100 Australian companies, Broadbent et al. (1993) found that 60% of the respondents thought BPR was an issue of critical importance for a company. Carr and Johansson (1995) conducted a survey of 47 companies in an attempt to identify the main reasons for undertaking BPR. The results are shown in figure 2.3:

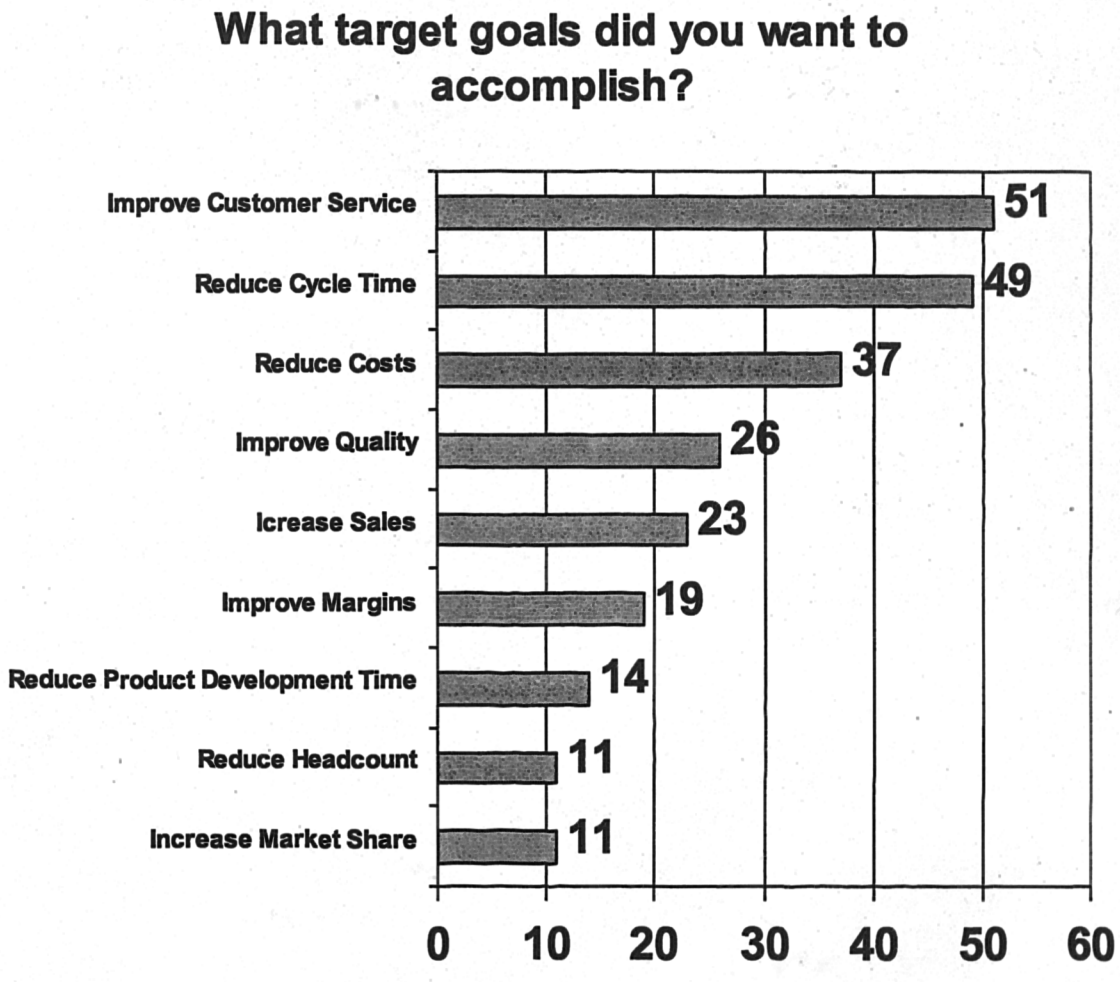


Figure 2.3: Reasons for undertaking BPR, Carr and Johansson, 1995

2.2.1 Is BPR a new concept?

Frederick Taylor's basic aim was to increase organisational productivity by applying to the workforce the same engineering principles that he used in order to solve technical problems. The same principles of structuring mechanical activity could also be used to structure jobs performed by people. Taylor radically transformed the workplace by redesigning the major traditional organisational functions. Consequently, scientific management is actually one of the deep roots of BPR (Coulson-Thomas, 1997).

BPR theorists such as Hammer (1993) and Davenport (1993) argue that the concept has strong linkages with past events. Davenport (1993) points out: "*So what is new about re-engineering? It is that familiar concepts are combined in a new synthesis*". Although re-engineering is based on familiar concepts such as organisational transformation or change management, the new element is that these concepts are combined in a new synthesis.

As a result, BPR differentiates from other management concepts such as total quality management. While both are based on the assumption that business process performance is critical to competitiveness, they are quite different regarding objectives, methods, results and business circumstances (Butler, 1994). Quality management programs emphasise incremental improvement, which may often take a number of years to complete. On the other hand, although there are different BPR methodologies, which suggest either incremental or radical improvement, the results of a BPR initiative can be realised in a shorter time using stronger links with enabling technologies.

In conclusion, BPR is based on tools and techniques from a variety of disciplines such as industrial engineering, quality management or systems analysis. Some of its characteristics can also be found in older management theories and concepts such as process redesign or business restructuring. There are, however, some distinctive features such as strong links with technology and an increase in capability and competitiveness.

2.2.2 What are business processes?

Business Process Re-engineering can be described as a means of facilitating significant - even fundamental - change in the way an organisation operates. A key element is the focus on process (Willcocks and Smith, 1995). Davenport and Short (1990) have defined business processes as "*a set of logically related tasks performed to achieve a defined business outcome*". Hammer and Champy (1993) defined business processes as *"a collection of activities that takes one or more kinds of input and creates an output that is a value to the customer"*.

Processes have two important characteristics:

- They have defined business outcomes, and there are recipients of those outcomes. Customers may be either internal or external.
- They have cross-organisational boundaries which means that they normally occur across or between organisational subunits. As a result, organisational processes include inter-organisational processes that take place between two or more different organisations and inter-functional processes which are internal processes but they cross several different functions or divisions and which achieve major operational goals.

Davenport and Short (1990) give a second dimension that concerns two main types of process objects involved in the operation of processes.

- Physical objects where tangible things are either created or further developed
- Informational objects where processes either create or handle information.

In addition, Davenport and Short (1990) describe the main process activities which are:

- Operational activities: where operational processes involve day-to-day activities such as customer service processes
- Managerial activities which help to control, plan or provide resources for operational processes

Process orientation represents a new approach to organisational analysis. The purpose of business process re-engineering, as with other quality movements, is the transformation of business processes. The desire to achieve such tranformation shows that processes play a strategic role within an organisation. Schnitt (1993) suggests that the new organisational transformation is based on processes instead of departments or functions. As a result, redesign of processes should be undertaken following a specific business vision and objectives. Harvey (1995) argues that companies that looked at their organisation from a process perspective have found that their core processes were inefficient because the activities which compromise them were fragmented, unco-ordinated and unmanaged. Most of the operational performance problems from which companies suffer are caused by the inefficient way in which processes are carried out.

In conclusion, process awareness and process thinking are critical factors for a successful business process re-engineering since this kind of initiatives focus on refining and integrating the components of core processes in new ways.

2.2.3 Theoretical framework for Business Process Re-engineering

The most fundamental implicit orientation of the BPR literature argues that high performance has to be based on the fit between an organisation's strategy, structure, technology, culture, management processes, and individual skills and roles, as illustrated by the MIT 90s model shown in figure 2.4, (Scott Morton, 1991):

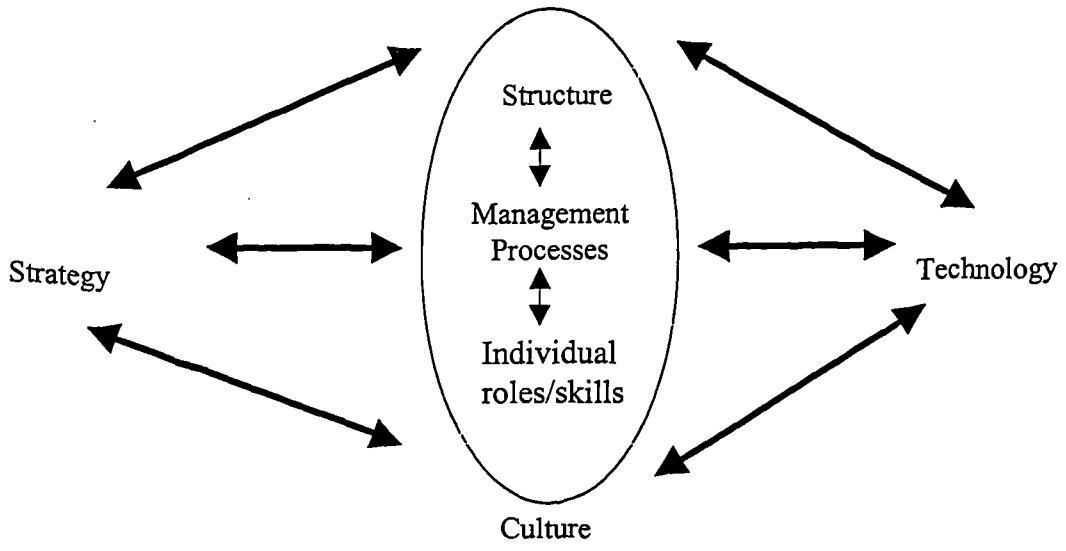


Figure 2.4: MIT90s framework, Scott Morton (1991)

Craig and Yetton (1994) pointed out that, while the idea of fit and a framework such as the above is static and there is no implication of any sequencing, most applications of this model assume that the first step is to determine the strategy. The second step is to fit the structure to this strategy and then to align the management processes, technology and individual skills to that structure (figure 2.5)

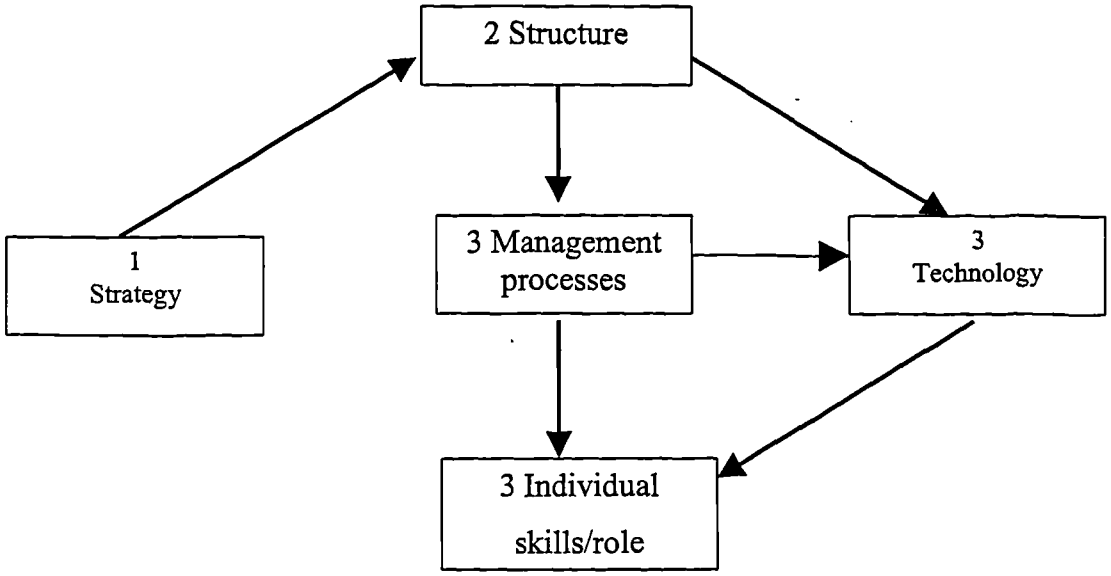


Figure 2.5: Conventional Model of Strategic Dynamics, Yetton, Johnston and Craig (1994)

Craig and Yetton (1994), in their critique of business process re-engineering, suggested a reconfiguration of the MIT90s model placing the technology at the centre. They pointed out that technology performs two roles: the first as a determinant of the new strategy and the second as an element to be aligned with the new strategy-structure model. As figure 2.6 shows, the BPR literature focuses on the relationship between strategy, technology and structure (the top triangle), suggesting a top-down approach - a radical approach based on strategic planning. In contrast to the BPR literature, BPR activity involves technology, management processes and individual skills and roles (the bottom triangle) and requires a more incremental approach.

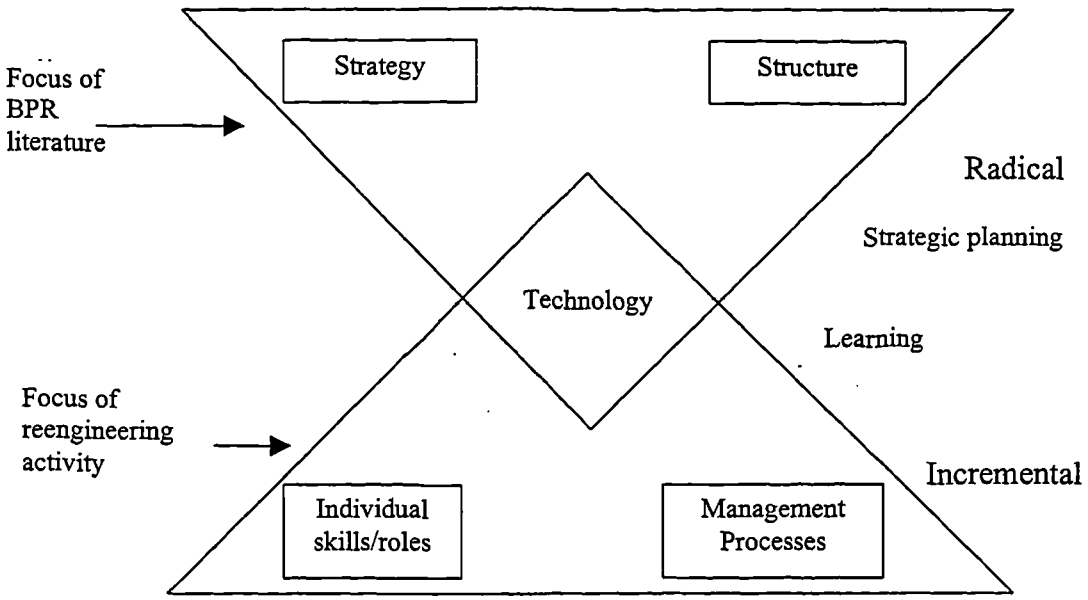


Figure 2.6 Different focuses of BPR literature and BPR activity, Craig and Yetton, 1994

Although technology is represented as the link between the two triangles, it is clear that this model is a dichotomy which keeps apart the top and bottom triangles confirming that there is a difference between BPR literature and the real activity of BPR. As a result, the alternative theoretical context for BPR developed by Craig and Yetton (1994) focuses on the bottom triangle *"because BPR fundamentally involves the organisational learning of new ways of operating"*. The resultant changes of the nature of BPR cannot be designed by experts or managers and implemented immediately by means of a new structure or strategy. These changes require new skills and roles for individuals, new management processes, new forms of organisational culture and information technology activities. The nature of such change requires an incremental and gradual approach because issues such as individual capabilities and an organisation's ability to evaluate performance and learn are involved. This approach does not support the opinion that the top and bottom triangle are mutually exclusive. Theorists of strategy development and implementation have shown that strategy formation is an emergent process involving small steps and ongoing changes based on the evaluation of the existing situation (Hamel and Prahalad, 1994). As a result, the strategy does not determine the

structure and the other elements of the model, rather the whole configuration evolves together.

The static models can, therefore, not continue to exist in the current dynamic and competitive environment and as a result companies should accelerate organisational learning to outpace competitors in building new advantages and to become or remain competitive (Hamel and Prahalad, 1994). According to Craig and Yetton (1994), a theory of organisational learning and incremental change is a co-requirement of these models of emergent strategy. Effective organisational learning and strategy development requires goals and feedback, which are the main elements of the evaluation and more specifically of the evaluation culture - a new form of organisational culture (which will be discussed later in this chapter).

2.2.4 Business Process Re-engineering in Europe

There is no definite empirical evidence which attempts to estimate the number of existing corporate transformation programmes in Europe, nor the specific proportion attributable to BPR (Coulson-Thomas, 1995). However, many studies have indicated that a large number of change initiatives are under way (Willcocks and Smith, 1994). BPR applications are more prevalent in some countries than others. The concept is widely applied in countries such as Germany, the UK, Sweden and the Netherlands. Interest is growing in countries such as France, Belgium and Italy, yet it is less known and applied in countries such as Greece and Spain (Coulson-Thomas, 1995).

In the UK, for example, there is a well known re-engineering community and many organisations have undertaken BPR projects - not all of which have been successful. Finally, in France, there are two main approaches to BPR. Some French managers believe that BPR has the potential to improve competitiveness whilst others argue that BPR is a simple way of *"presenting a restructuring and/or downsizing exercise within an organisation"* (Coulson-Thomas, 1995).

2.3 Organisational readiness for business process re-engineering

2.3.1 The role of Information Technology in modern organisations

Information Technology (IT) has penetrated the office and services environments. In 1982 Business Week reported that 40% of all US capital went towards investment in information systems. The technology can be employed to achieve a wide variety of benefits but any kind of technological application or innovation represents a potential risk. Starting with the benefits, Eason (1992) presents a classification of information technology benefits based upon a continuum from resource reduction to work enhancement. The first benefit is related to cost savings. IT applications save the costs of paper and space, if everything is stored electronically. The second source of benefits is referred to the reduction in the number of people employed which is the major cost in offices.

Another alternative to the staff deployment could be the achievement of higher productivity from existing resources using IT. It has been argued that the implementation of a new system is easier, if the ground rule is not to reduce resources but to perform the tasks using existing resources (Eason 1992). For example, the introduction of a new banking system may help existing bank clerks to service more customer accounts.

The third major group of benefits has the potential to enhance an organisation's effectiveness in terms of quantity or quality of work. The possibilities for using IT applications in order to aid, support or facilitate are numerous. They range from general purposes tools such as word processing, applications for storing and retrieving data, etc. to more complicated applications such as computer aided design. In each case the purpose is to give to the person some advantage in pursuing the task –to enhance the task performance or/and the quality of the outcome. IT can also be used to improve access to valuable information in order to support decision-making.

Finally, IT has given organisations the opportunity to seek new objectives that could not otherwise be achieved. These objectives can take the form of either internal goals such as optimisation of resources, or external objectives such as expansion in new areas of business. Consequently, Thurow (1989) argues that IT has been used in most cases to hasten office work rather than to transform it. He also indicates that aggregate productivity figures for the United States have shown no increase since 1973. Furthermore, Mowshowitz (1976) showed that 20% of information systems implemented achieve something like their intended benefits, 40% fail and the remaining 40% make only a marginal impact on the organisation (figure 2.7). Also, Loveman (1988) studied the productivity of manufacturing firms to estimate the impact of IT in the late 1970s and early 1980s. He found no significant positive productivity impact from IT and he argues that his results in manufacturing firms raise serious questions about the productivity impact in non-manufacturing firms as well.

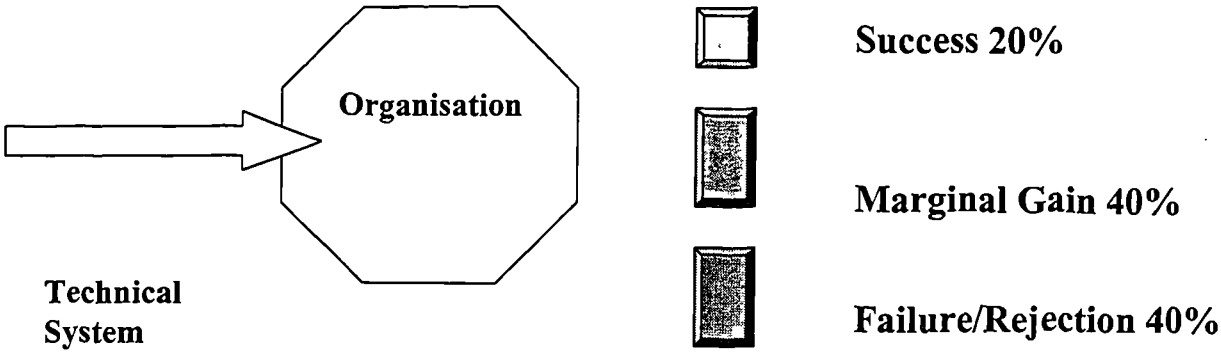


Figure 2.7: Success rates in information technology applications, Mowshowitz (1976)

More recently, Morris and Brandon (1993) analysed the use of technology in business based on studies at MIT (Massachusetts Institute of Technology). MIT conducted research on the productivity of technology and on the return of computing investment. Their findings indicated that there is no direct correlation between IT and increased profit. The studies do show, however, that there is a relationship

between information technology and bottom line improvement and that companies which invest in certain definitive ways tend to make profit out of their investments.

All these findings gave rise to various debates regarding the role of information technology in the increase of productivity. Although, many academics and practitioners have analysed statistics extensively during the 1970s and 1980s, they found no correlation between the use of information technology and increase of productivity. This phenomenon, known as 'productivity paradox', led to more researches and discussions. Brynjolfsson and Yang (1996) reported that several researchers have found evidence that ' IT is associated not only with improvements in productivity, but also in intermediate measures, consumer surplus, and economic growth' because of the identification of new data and the application of new methodologies.

2.3.1.1 The enabling factors of information technology

The most familiar use of IT is *automation.* Automation implies the strengthening of the structure of business processes and the partial or entire replacement of manual labour with computerised machinery (Petrovic and Zsifkovits, 1994). The enabling factor of automation is effective in two areas of the redesign of business processes. Firstly, an IT based process is more likely to be less time consuming and less costly for the organisation. The time and cost reduction can bring dramatic cost savings to a company. Secondly, the structure of the business processes is modified so they can be standardised and, therefore, easily automated. As a result, errors can be minimised, routine duties can be avoided, training of new employees is easier and internal and/or external communication is facilitated. There has been strong criticism of this enabling factor because automation can lead to repetition of tasks which reduces creative potential and is, therefore, responsible for a lack of self-initiative and self responsibility.

A second enabling factor is the use of IT in order to increase information about individual business processes, to enhance the information potential of employees and to provide access to knowledge and experience (Zuboff, 1988). The

automation of business processes leads to increased information about these processes. A typical example would be an electronic document management system which not only automates document management processes but is also able to provide an audit trial of all activities that take place during this process.

As a result, employees have better access to information which allows them to think of alternatives, to communicate with their colleagues, to have a better understanding of the whole process and to have easier and better access to knowledge and experience. The enabling factor of increased information allows a more co-operative way of working and a more decentralised organisational structure. However, the main problem of this use of IT lies with the concept of knowledge sharing (Petrovic and Zsifkovits, 1994). In many organisations expertise and information are used as a basis for remuneration and advancement within the company. As a result, the information sharing which is enabled by IT applications may actually create resistance to use IT and reluctance to share knowledge and experience.

A further enabling factor of IT is the reduction of time and location limitation. Individual tasks can be performed at different times and places and therefore the number of potential partnerships is expanded beyond the physical location of the organisation. Consequently, the response to customer or partner demand is easier and faster mainly through electronic integration which is based on electronic data interchange.

Parallelisation is a very important factor that enables tasks previously handled sequentially to be carried out simultaneously. The CONDOR approach is a justification of this use of IT since it promotes information and document sharing by various actors collaborating concurrently on projects.

Finally, the increased information, the reduction of time and location limitation and the parallelisation lead to the fifth enabling factor which is the integration with effects on both internal and external processes. Through access to information without time or location limitation and better understanding of the entire

business process, co-operation and communication within and between companies is enabled.

2.3.1.2 Three critical shifts in the application of information technology

The above analysis shows that information technology enables organisations to have a high performance team structure, to function as an integrated business and to develop new relationships with external organisations (Tapscott and Caston, 1993). There are three fundamental shifts now occurring in the application of the IT (figure.2.8). Advances in technology allow many companies to transform their organisational structure.

The first shift is related to workgroup computing. Organisations are changing the way people work. Information technology enables companies to shift from the traditional highly structured, hierarchical organisation to the business team which can function beyond traditional organisational boundaries (Tapscott and Caston, 1993). Personal computers have improved many aspects of an organisation such as time saving, improved quality etc. Direct access to technology has enabled people to be more productive and to be able to meet their individual work objectives more effectively.

On the other hand, personal computers were incompatible with the way people work which is based on communication with others, exchange of information and teamworking. New forms of technological applications such as work-group computing gave the opportunity to the organisation to be transformed into an open networked one. Thus, people begin to function more effectively as groups in an organisation and share information more accurately. Consequently, existing business processes, procedures, job types and organisational structures are changing This new form of organisation is based on a more co-operative way of working and on multidisciplinary teams. Within this context the need for re-engineering the existing processes, structures and roles is crucial.

The second fundamental shift in the application of information technology is the integrated systems that led to organisational transformation. Old information

systems that supported central organisational functions such as financial management or human resource management used to act separately and they were highly fragmented. The result has often been organisational conflict, lack of co-operation between those involved in different tasks and many difficulties in meeting overall business objectives and strategies. The development of new applications and the maturity of technology standards now allow a more cohesive organisational form where people have instant access to information and there are no more technical or structural barriers. The technology, therefore, enables a more decentralised structure where the management layers are eliminated.

Information technology enables organisations to develop new relationships with external organisations in order to become an "extended enterprise" (Tapscott and Caston, 1993). This new role of IT comprises the third fundamental shift in its application. Partnerships between companies are facilitated, national and international co-operations are supported and customer demands are more easily satisfied because of the applications of the new technology. The CONDOR project can be used as a case study where a partnership between English, Swedish and French companies is based on the effective use of IT as a tool in order to achieve information sharing and exchange among different organisations.

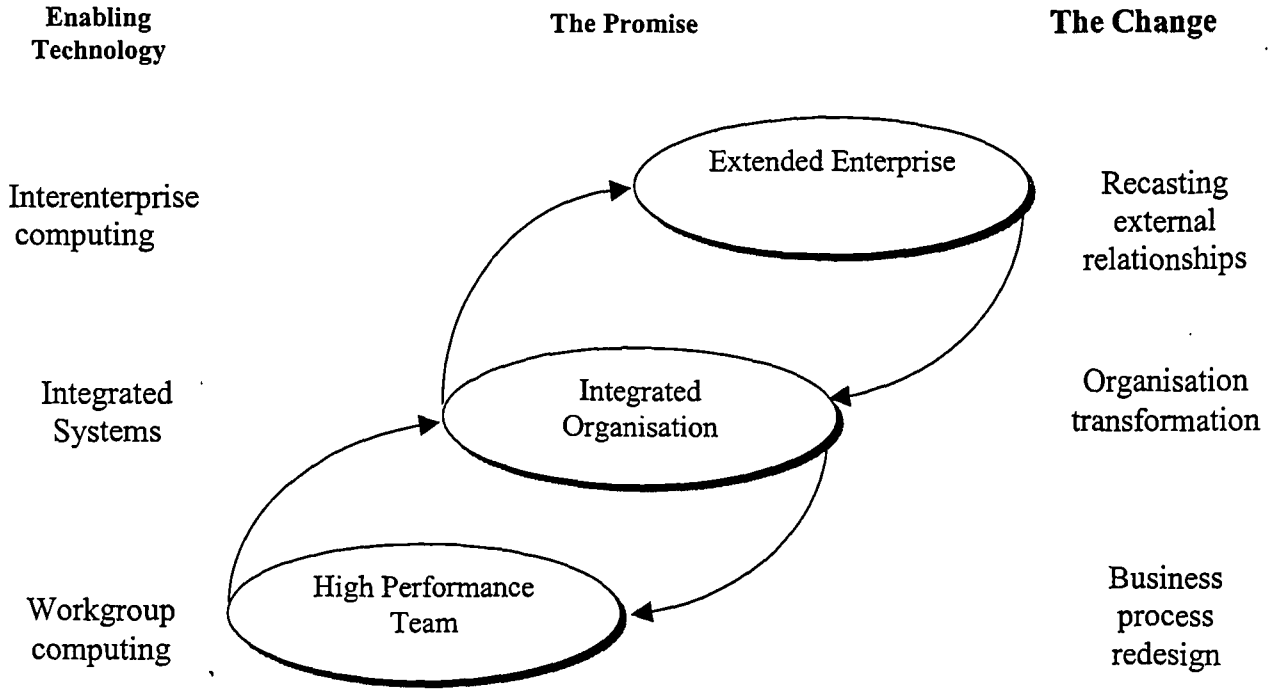


Figure 2.8: The enabling effect of information technology, Tapscott and Caston, 1993

2.3.1.3 Information Technology and Business Process Re-engineering

The above analysis shows that companies increasingly are starting to apply a more team oriented, co-ordinative and communication based way of working in the workplace supported by the new developments in IT applications. Davenport and Short (1990) have argued that rather than maximising the performance of particular individuals or business functions, organisations should concentrate on the maximisation of interdependent activities within and across the entire organisation. Crowston and Malone (1987) suggested that IT is the most powerful tool for reducing the cost of this co-ordination.

Morris and Brandon (1993) identify various ways in which IT can support business processes as shown in Table 2.1. One example is that IT can have a sequential impact in the sense of changing the order in which processes are carried out, and in particular, can allow activities to be carried out in parallel.

• increasing speed	• controlling business tasks and improving quality
• communicating	• storage and retrieval
• monitoring	• manufacturing and delivering services
• supporting decision-making	• supporting process work functions

Table: 2.1: IT support for Business Processes, Morris and Brandon, 1993

These reasons can justify the increase in IT investment. The results of a recent survey, which took place in construction companies in Scandinavia, show that there is a change in IT spending. More specifically, in Denmark 68% of the firms surveyed had increased their IT investment in the previous two years, while only 47% planned to increase it in the following two years. Accordingly, 68% of Finnish firms have increased their investment in IT and 52% of them expect to increase it in the following two years. Finally, in Sweden, 94% of the firms have increased their IT spending and 77% of them expect to increase it more in the future (Howard, 1998).

Hammer (1990) argues that information technology is the key enabler of business process re-engineering which he considers as "radical change". Business needs are multiplying the demands for increased capabilities of IT applications. In turn, increasingly advanced IT is being utilised in more and more sophisticated ways

to enable businesses to survive in the current competitive environment. In this context, IT plays an important facilitating role. It is clear that IT has evolved from its traditional orientation of administrative support role toward a more strategic role within an organisation and more specifically within the construction industry.

Also, Teng et al. (1994) point out that although IT is not necessary for BPR, it is a critical factor of its success. One example is Citibank's change of credit analysis system. A computerised system of dealing with accounts was implemented which was less time consuming and more effective. The time that employees spent on recruiting new customers increased from 9% to 43% and as a result the profits have increased by 750% over a two-year period. IT has the potential to enhance organizational efficiency and effectiveness by eliminating delay, administrative intermediaries, and, errors and by providing better access to information (Teng et al., 1994). Davenport and Short (1990) suggest that BPR and information technology have a recursive relationship (figure 2.9). They argue that BPR and IT are interlinked and each is the key to thinking about the other. Business processes should be considered in terms of the capabilities that IT can provide. On the other hand, IT should be considered in terms of how it supports new or redesigned processes rather than other business functions.

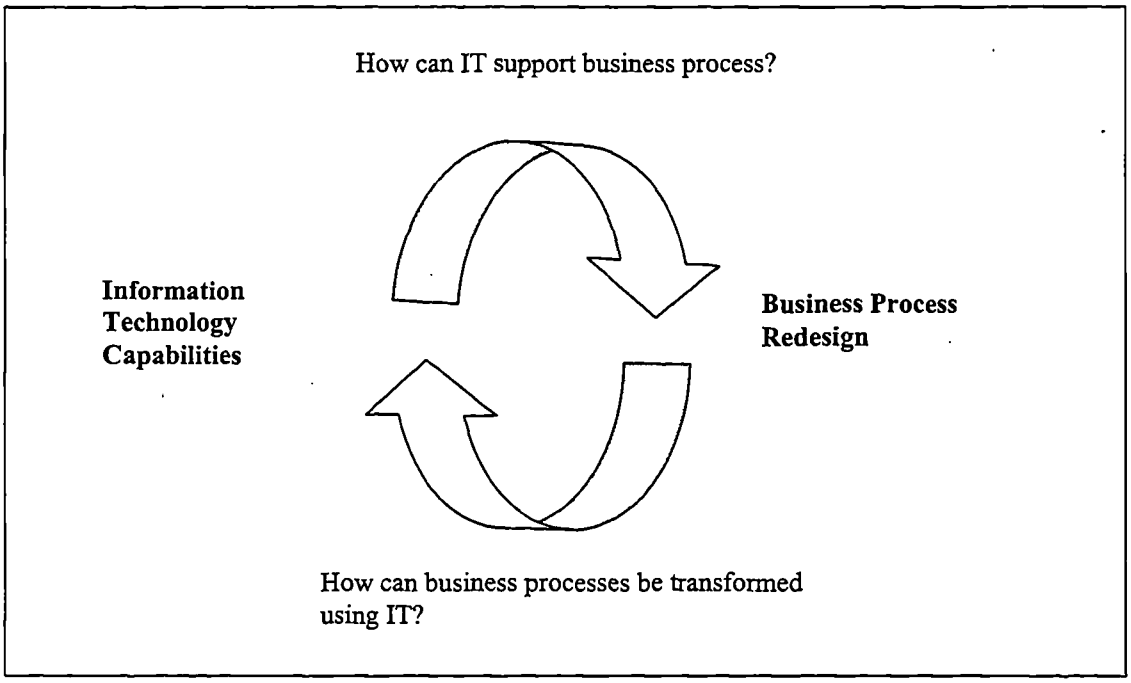


Figure 2.9: The Recursive Relationship between IT Capabilities and Business Process Redesign, Davenport and Short, 1990.

It has been argued that failed BPR efforts are often a consequence of not being imaginative enough in capturing the potential of IT, and staying too close to the current work arrangements (Craig and Yetton, 1994). Davenport (1993) provides the most detail analysis of the role of IT in the re-engineering process. He suggests that the business process re-engineering requires taking a broader view of both IT and business activity and of the relationships between them.

Information technology should be viewed as more than an automating and mechanising force. This means that the new IT applications have the potential to fundamentally reshape the way business is done. Davenport (1993) suggests that process may be a mediating factor between the IT and economic return indicating that "*if nothing changes about the way work is done and the role of IT is simply to automate an existing process, economic benefits are likely to be minimal*". Short and Venkatraman (1992) agree with Davenport and explain that many companies use IT to automate existing processes rather than to redesign them.

Also, Craig and Yetton (1994) indicate that the use of IT in order to create a basis for competitive advantage is an important issue in the BPR literature. According to the MIT90s model, discussed earlier in this chapter, a prerequisite for high performance is the fit between an organisation's strategy, structure, management process, technology and individual skills and roles (Scott Morton, 1991). Here, it is important to emphasise the dual role of IT in the re-engineering process. Craig and Yetton (1994) report that IT is or must be an integral part of the design and implementation phase. IT has got the potential to turn the new design of a process into work practices and consequently into business benefits. This role is closely linked with the business strategy and structure. In addition to this strategic role, IT plays an important role in the change process during the implementation phase, which also leads to business benefits.

Davenport (1993) argues that such benefits occur through three mechanisms. The first one lies in the relationship between BPR and speed. The success of BPR initiatives is often determined by the optimisation of time. IT can improve design and implementation speed, which is argued to be very crucial in a re-engineering effort. Secondly, low quality during the implementation phase affects the progress of

BPR results and quality is enhanced by systems analysis techniques or other IT developments. Finally, failure to capture the potential of IT in the implementation phase may be an indicator of insufficient management awareness of the relationship between BPR and key business processes.

In conclusion, the above analysis shows that the literature emphasises the role of IT in business process re-engineering and BPR is often treated as an IT issue. The latter depends on the background of the author. For example, Davenport (1993), who is an IT consultant, emphasises the role of IT and the phases for designing and implementing BPR while Morris and Brandon (1993) point out that BPR is not an information technology topic. According to Craig and Yetton (1994) the lack of attention from an organisational/strategic and human aspect is surprising. As a result, BPR which is a phenomenon with major strategic and organisational significance is receiving little attention outside the IT area.

2.3.2 Linking re-engineering to business strategy

Many BPR projects have failed and many academics and practitioners have analysed and discussed the effects of such change initiatives to the whole organisation. There are examples in the literature which refer to 'missing ingredients' and suggest 'recipes' of success for re-engineering efforts (Harvey, 1995; Oram and Wellins, 1995). Apart from the role of IT which is well defined and understood, there are a number of supporting concepts which play a major and strategic role within the re-engineering process such as business strategy, organisational culture, structure, motivation, organisational development etc. (Kettinger and Grover, 1995). There is a plethora of concepts associated with BPR and its success or failure. As mentioned in the introduction to this chapter, the researcher has chosen to put more emphasis on the role of IT, business strategy, organisational culture and human resources management according to the aims and objectives of both the CONDOR project and the current thesis.

The concept of strategy covers a broad range of conceptualisations, definitions and meanings. However, business strategy is defined *"in terms of*

choices pertaining to the positioning of the business in the competitive product-market arena" (Venkatraman, 1991). This definition includes three basic dimensions, which are:

- business scope which refers to products/services and markets,
- distinctive competencies which involves the characteristics that distinguish the firm in the competitive market such as superior service or product design and
- business governance which includes the choices of structural mechanisms in order to organise the business operations such as joint ventures or strategic alliances (Henderson and Venkatraman, 1994).

The 1990 and 1991 'Managing the Flat Organisation' surveys revealed that managers face a turbulent and demanding business environment (Coulson-Thomas, 1997). In order to survive in an environment of multiple challenges and opportunities, companies have to a) differentiate themselves from competitors and b) become more flexible, responsive and adaptable (Coulson-Thomas, 1997). The 1990 survey also reveals the extent to which changes affect the companies: *"Approaching nine out of ten of the participating organisations are becoming slimmer and flatter, while in some eight out of ten more work is being undertaken in teams, and a more responsive network organisation is being created"*. Within this context, which involves change, uncertainty and strong competition, business strategy is a critical success factor.

Porter (1980) links business strategy and competitive advantage. He argues that there are two basic types of competitive advantage: lower costs and differentiation. Lower cost emphasises the ability of the firm to design, produce and sell a standardised product or service more efficiently than its competitors without neglecting the quality. Differentiation is the ability to provide unique and superior value to the customer in terms of the service itself, the delivery system etc. Another important variable is the competitive scope or the breadth of the firm's target within the its industry. Competitive scope is important because industries are segmented and serving different segments requires different capabilities and strategies.

According to Porter (1980) a critical assumption is that competitive advantage is determined by industry dynamics and that organisations have to position their products and services in selected markets in order to gain advantages. A company's competitive position and its chosen products/services and markets are important, but only at any given point in time. In a rapidly changing competitive environment, products and services easily become obsolete and static competitive positions are rapidly overtaken. As a result, companies have to be able to respond consistently to changing markets with improved or new products/services and ever improving competitiveness (Peppard and Rowland, 1995). A firm can achieve this ongoing renewal by identifying, developing and maintaining its critical capabilities (Prahalad and Hamel, 1990). Capabilities are a "*company's proficiency in combining people, process and technology which allow it to continually distinguish itself along the dimensions that are important to its customers*", (Peppard and Rowland, 1995). Consequently, business strategy is composed of both market focused and capabilities focused perspectives, both of which are essential.

This dual approach to business strategy does not, however, adequately address the critical issue of implementation. There is a general consensus on distinguishing between the cognitive aspects of strategy (formulation) and the action component (implementation) (O'Farrell et al., 1992). Starting with the role of business process re-engineering as a strategy formulation tool, Peppard and Rowland, (1995) suggests that business process re-engineering involves the development of an organisational architecture which includes identification of core processes and their objectives.

Business process re-engineering draws together two critical concepts. The first is the fact that a few key processes determine the competitive success of a company. The second concept is that the entire set of activities involved in delivering a business process should be managed as one unit or flow of work and that the customer's expectations and needs should determine the objectives of that process (Craig and Yetton, 1994). These concepts are not unique to business process re-engineering. The first one is based on the competence/capability approach to business strategy and the second comes from the quality movement. According to Craig and Yetton (1994), however, "*the innovation of BPR lies in rolling together,*

into one activity, the two steps of conducting a strategic analysis (identifying core business processes) and developing a detailed blueprint for the new vision (redesigning those processes)".

This raises the questions 'can business process reengineering bridge the gap between strategy formulation and implementation?' Burke and Pepperd (1995) suggest that by identifying the processes which underlie the strategy, business process re-engineering gives a greater direction to implementation. But there is no evidence in the literature suggesting that re-engineering facilitates strategy implementation. The only indication is that the forging of the link between business strategy and business process re-engineering is the first step in strategy implementation (Pepperd, 1984). All these concepts of strategy formulation, business process re-engineering and strategy implementation become even more important when companies have to survive in a continuously changing and very competitive environment where the relationship between the formulation and implementation of generic business strategies and performance is crucial (O'Farrell et al., 1992).

In conclusion, although business process re-engineering must be part of strategic change within the organisation, the link between strategy and BPR has not been addressed in a meaningful way (Preece and Peppard, 1993). The emerging 'behavioural view' which focuses on core competencies and organisational capabilities would seem to provide a more useful way of understanding and identifying processes as opposed to the traditional approach to strategy which emphasises products and markets. According to the competence-based strategy, business process re-engineering has to focus on redesigning and supporting the distinct competencies of the organisation. The traditional approach focuses on composition of the product portfolio and on the market selection, which can be easily copied by the competitors. Competence-based strategy deals with establishing excellence in the core competencies, such as technological or operational excellence etc, necessary to operate effectively in the chosen market.

2.3.2.1 Strategic Re-engineering

Harvey (1995) underlines the importance of relating process re-engineering to the strategic goals of the organisation and argues that many companies are forced to look at the re-engineering from a strategic perspective because this is one of the reasons why initiatives either fail or don't produce the expected results. Other authors have analysed the importance of the relationship between strategy and business process re-engineering and many papers have been written about the value of strategic re-engineering (Hamel and Prahalad, 1994; Schnitt, 1993; Craig and Yetton, 1994).

Strategic Re-engineering focuses on designing the organisation to compete, with the recognition that every business process in an organisation must serve the strategy of the organisation in order to compete effectively and survive in a competitive market. Any transformation or change of process, structure, management, culture or resources will probably be unsuccessful if it is not related to the company's fundamental aim. Harvey (1995) suggests:

> *"You don't want to fundamentally change your processes if you don't know where the business is going"*

The organisation has to understand and assess its market, its competitors, and the attributes that affect its success such as its people, processes and technology in order to make strategy an integral part of the re-engineering process.

However, although the necessity to combine business process re-engineering with business strategy is well known, it is not clear how to translate a vision into specific objectives for a process-based organisation and whether this is an appropriate approach (Preece and Peppard, 1993). The majority of the authors emphasise the importance of strategic re-engineering and suggest typical initial stages through which companies will sustain competitive advantage such as assessment of the industry and the competitive situation of the organisation, analysis and benchmarking of the competitors etc. But it has been argued that the traditional emphasis of strategy only on products and markets is not able to support a business

process re-engineering initiative. Consequently, according to Preece and Peppard (1993), the organisation needs to assess not only its markets, the needs of its customers and the development or improvement of its products/services but also its organisational capabilities.

2.3.3 The Nature of Organisational Culture

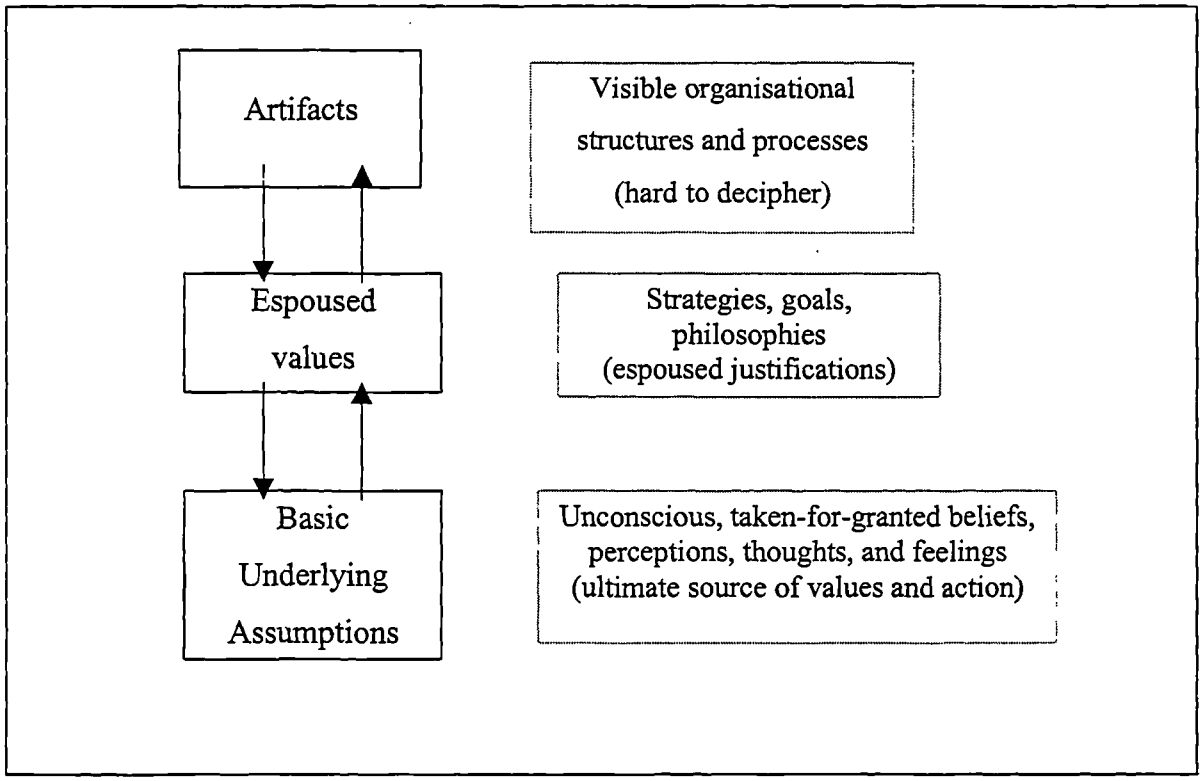
Although the concepts of 'group norms' and 'climate' have been used by psychologists and organisational theorists for a long time, the concept of 'culture' has been used over the last few decades (Shein, 1990). Although organisational culture has become a fashionable concept, there is a disagreement concerning its definition. Hofstede (1991) argues that there is no standard definition of the concept, but most people 'agree' that organisational culture is:

- holistic, referring to a whole which is more than the sum of the parts
- historically determined, reflecting the history of the organisation
- related to the things anthropologists study, such as rituals and symbols
- socially constructed, created and preserved by the group of people who together form the organisation
- soft, (although there are some authors who assure their readers that 'soft is hard')
- difficult to change,(although authors disagree on how difficult)

Hofstede (1991) defines organisational culture as *"the collective programming of the mind which distinguishes the members of one organisation from another"*.

Shein (1992) gives another definition regarding culture. He argues that culture can be defined as *" a pattern of basic assumptions invented, discovered, or developed by a given group, as it learns to cope with its problems of external adaptation and internal integration that has worked well enough to be considered valid and, therefore, is to be taught to new members as the correct way to perceive, think and feel in relation to those problems"*.

Shein (1992) continues by describing the main levels of culture. As figure (2.10) shows, the first level is the artifacts. This category includes "*the visible products of the group, such as the architecture of its physical environment, its language, its technology and products, its artistic creations, and its style as embodied in clothing, manners of address, emotional displays, values, observable rituals and ceremonies, and so on*". Consequently, artifacts or norms are unwritten and socially transmitted guides to behaviour. The most important point about this level of culture is that it is easy to observe and very difficult to decipher.



The second level of culture is related with the espoused values. Value systems relate behaviours across units and levels of the organisation, with values being shared by the organisation as a whole or by distinct subunits. These values and rules are very important because they guide members of the group in how to deal with certain key situations and in training new members in how they should behave. The final stage is related to basic assumptions. Shein (1992) explains that basic assumptions are similar to what Argyris (1985) identified as "theories in use", which are "*the implicit assumptions that actually guide behaviour, that tell group members*

how to perceive, think, and feel about things". This level of culture represents the relationship between ideas and is responsible for an organisation's decision making.

Although it has been argued in the literature that the concept of culture is difficult to be defined and assessed, it is generally agreed that culture plays a very important role in every organisation. Shein (1992) identifies some of the functions performed by culture as shown in the following table (2.2):

External adaptation task	**Internal integration tasks**
Developing consensus on:	*Developing consensus on:*
1. The core mission, functions, and primary tasks of the organisation vis-à-vis its environments.	1. The common language and conceptual system to be used, including basic concepts of time and space
2. The specific goals to be pursued by the organisation	2. The group boundaries and criteria for inclusion
3. The basic means to be used in accomplishing the goals	3. The criteria for the allocation of status, power, and authority
4. The criteria to be used for measuring results	4. The criteria for intimacy, friendship, and love in different work and family settings.
5. The remedial or repair strategies if goals are not achieved	5. The criteria for the allocation of rewards and punishments
	6. Concepts for managing the unmanageable-ideology and religion

Table 2.2: Functions of culture in resolving problems of external adaptation and internal integration, Shein, 1992

2.3.3.1 Organisational culture and change

Given the changing nature of organisations today, organisational culture is more important than ever before (DeLisi, 1990). The concept of culture is seen as critical to the success of any kind of major organisational change, particularly where organisations are moving to process based ones using IT (Preece and Peppard, 1993). The focus on process makes re-engineering multidisciplinary and cross functional

and implies cultural change (Willcocks and Smith, 1995). If proposed changes contradict cultural traditions, it is inevitable that they "*will be difficult to embed in the organisation*" (Oram and Wellins, 1995). DeLisi (1990) argues that some currently available technologies have the potential to improve organisational functions such as decision making or teamwork but networking capabilities will not be realised and fully used, unless the networks fit the existing organisational culture.

DeLisi (1990) presents an operational description of organisational culture which includes customs and norms, rules and policies, goals, rewards and recognition, organisational structure, management behaviour, physical environment and communications. She suggests that these are tangible elements of culture that can be managed. Also, Oram and Wellins (1995) suggest that the "existence of a strong and clearly articulated culture" can be considered as an enabler to effective performance. However, many economists and organisational theorists believe that culture is irrelevant to an understanding of organisational performance (Willkins and Ouchi, 1983). Wilson (1992) argues that:

> *"to effect change in an organisation simply by attempting to change its culture assumes...a linear connection between culture and performance...[and] it is not clear how culture and performance are related, if at all"*

Nevertheless, Burnes (1992) suggests that it is when culture becomes 'out-of-step' with changes in the environment, structures and practices of the organisation, that dysfunction occurs and it becomes inappropriate to effectiveness. He continues:

> *"...given that culture is locked into the beliefs, values and norms of each individual in the organisation, and because these are difficult constructs to alter, this type of organic cultural change will be slow, unless perhaps there is some major shock to the organisation".*

Burnes (1992) examines the relationship between organisational culture and change and suggests that change strategies and initiatives must be 'culturally sensitive'. He presents the major reasons which lead to resistance to change such as lack of awareness and understanding, lack of skills and politics, stressing the major

importance of organisational culture as an inhibitor of change. Organisations must realise that the process is difficult, lengthy, dangerous and needs a lot of support and reinforcement, if culture change is to be sustained overcoming the tendencies to regress to old behaviours. There are many examples of how an organisation experiences great distress because the 'culture' cannot be changed or because its members will not change the 'culture' fast enough. For example, Hewlett-Packard executives either cannot or will not change their structure of small divisions and their entrepreneurial 'culture' to meet the requirements for integrated pricing and product packages in the new small-computer markets in which the company seeks to compete (Business Week, 1982).

According to Shein (1992) organisations by their nature and by their design have a strong tendency toward stabilising and routinizing work where people don't have to reinvent the organisation each time they want to perform effectively. Organisations create cultures that are expressed in structures and processes that permit a large number of people to co-ordinate and co-operate. As a result, how can one conceptualise an organisation which can function effectively but still be capable of learning in order to adapt and innovate in response to continuously changing circumstances? Furthermore, what kinds of cultural assumptions must be present to facilitate organisational processes that will increase the likelihood that the organisation will be able to learn, adapt and innovate?

As Shein (1992) points out:

> *"Adaptation in turbulent environments requires more that minor adjustments to the present way of doing things. It often requires genuinely innovative ideas, new missions, new goals, new products and services, new ways of getting things done, and even new values and assumptions. Most important, adaptation means the developing of the capacity to manage 'perpetual change'. Organisations must 'learn how to learn'..."*

Within this continuously changing environment the dynamics of organisational culture is a critical factor for every organisation. A UK report based on extensive research shows that the top barrier to successful re-engineering is

"managing change" where organisational culture has been found to be the major inhibitor to re-engineering progress among US and European organisations (CSC, 1994). Business intelligence's survey findings identified the main barriers to and enablers of cultural change in a re-engineering context (Harvey, 1995):

Cultural enablers:

- Create a participative culture by:
  - Involving employees in decision making
  - Flattening organisational hierarchies and increasing spans of control
  - Encouraging employees to redesign smaller restricted process
  - Developing a learning organisation
- Managers must trust that employees have the capacity to gain the experience needed to perform their tasks
- Cultivate changes in values and attitudes, starting from top management

Cultural constraints and barriers:

- Organisations structures and cultures that support management along individual functions rather than across processes
- Strict hierarchical structures and organisational rigidity
- Cultures unreceptive to innovation
- Inability to accommodate change-status quo is the norm
- Functional organisations with characteristics based on:
  - The style of the leaders who have shaped the organisation
  - The power associated with the size and perceived importance of individual functions

These cultural enablers and constraints which are related with the re-engineering process of many UK companies indicate a choice between two different cultural approaches as more appropriate for sustaining competitive advantage in a continuously changing environment. As table (2.3) shows, there are two different approaches to organisational culture. On the one hand is the entrepreneurial culture with an emphasis on decentralisation, networks, creativity and so on. On the other

hand, there is a professional management culture which involves among other things centralisation, hierarchies and conformity (DeLisi,1990). Some of the features of the entrepreneurial culture seem to enable organisational culture change.

Entrepreneurialism	**Professional Management**
Internal Controls	External Controls
Creativity	Conformity
Individual Autonomy	Central Control
Intuitive	Rational/Logical
Right Brain	Left Brain
'That Ol' Gut Feel'	Scientific Management
Decentralisation	Centralisation
Distributed	Centralised
Networks	Hierarchies
Adult-adult	Adult-child
Person-Centred	Organisation-Centred
Product Differentiation	Low Cost producer

Table 2.3: Two approaches to Organisational Culture, DeLisi, 1990.

2.3.3.2 Evaluation Culture: a new approach to change

Kushner (1998) affirms that "*a pro-evaluation culture should be part of a wider organisational culture which helps to create shared understandings about what words and actions mean, and within which interactions can take place with the minimum of negotiation but with a tolerance for argument*". These are conditions that encourage people to orient their individual actions to the goals of the programme. "*Such conditions would be made up of a common vocabulary, sustained personal contact and a core (not a totality) of common values and interests, together with tolerance for where those values and interests diverge. An organisational culture is an achievement rather than a design; it is recognised through a feeling of community more than through statements of allegiance to common goals-it is that is to say, experiential rather than national*".

2.3.3.3 Strategic elements

It has been argued that pro-evaluation culture is based on several strategic elements and characteristics (Segone, 1998). All characteristics should be present but not necessarily at the same time. Trochim (1996) gives a description of the twenty first century evaluation culture defining its fundamental elements:

Action oriented: Evaluation should be regarded as an ongoing process. Evaluation should be an integral part of the cycle supposition-action-evidence-revision within the action research cycle. Evaluation should be a strategic instrument that facilitates and supports the use of information and knowledge acquired during the evaluative process, with the aim of strengthening programme performance. In this evaluation culture, the innovative approaches are encouraged at all levels.

Interdisciplinary and holistic: It has been argued that evaluation should become completely integrated in the organisational structure and in the planning and implementation of the programme and not seen as a parallel function. Evaluation must bee seen as an interdisciplinary function which is able to give a more holistic view of the programme's dimensions and implications as well as a broader spectrum of potential consequences.

Inclusive, participatory, responsive and non-hierarchical: Evaluation should be a daily activity of everybody working in the organisation to better analyse and improve his/her personal performance and overall organisational performance. Thus, there will be no further debate whether or not evaluation should be more participatory. It is well understood that fundamental problems are systemic and interconnected which is why solutions coming from interdisciplinary and flexible teams are required.

Ethical democratic and truth seeking: another fundamental component of the evaluation culture should be the ethical and democratic processes. Private ownership and exclusive access to data should be abandoned. All the stakeholders and interested parties are allowed to have access to data and to results. This will lead to

the opportunity of secondary analyses and to replication or refutation of original results. It is important to include formal opportunities for open discussions and responses from the involved parties. Also evaluation should be sensitive to the concerns of the stakeholders. Political and value issues are an integral part of evaluation and as a result evaluators need to understand the implications of their actions and establish a dialogue with all the involved members. In addition, evaluation should be sufficiently rigorous in design, data collection and analysis. Although the evaluation culture has to welcome stakeholder's contributions, it must not forget the accountability and scientific credibility.

Forward looking: evaluation culture should be prospective anticipating the necessity of evaluation feedback or results. Evaluation process should be utilised during the whole life cycle of a programme not only at the programme's end.

2.3.3.5 Strategic outcomes

The development of an evaluation culture within an organisation or programme affects organisational processes and results. Preskill and Torres (1996) argued that in this context organisations:

- are open to develop new ideas and strategies
- are able to change more quickly according to the pressures and variations of the external environment
- are able to unify processes
- experience increased efficiency and effective use of lessons learned to improve projects or programmes

Staff members and team members of such organisations:

- need less direction from the top management
- are more self-directed learners and use information to act
- work in teams trying to not meet instructions but to meet strategic goals defined through a participatory process
- are more consultative, more coaching and provide support for each other

- develop a greater sense of personal accountability and responsibility on the one hand but take higher risks on the other

2.3.4 Human resources management

Much has been written on the numerous reasons for failure associated with re-engineering. The failures can be caused by a number of reasons such as failure to take full advantage of the potential of IT (which was discussed earlier in this chapter), lack of sustained management commitment and leadership, unrealistic scope and expectations, resistance to change etc. Oram and Wellins (1995) have argued that the biggest cause of failure is a 'missing ingredient'. According to them:

> *"...re-engineering pays exclusive attention to information technology and process redesign breakthroughs. These may be fundamental, but in reality, these constitute only a part of the recipe for success. The human factor is a vital missing part"*

Many authors have shown that re-engineering in the use of information technology must be combined with a change in the way people use this technology (Burnes, 1992). A UK report based on extensive research shows that the major barrier to successful implementation of business process re-engineering is 'managing change' (Harvey, 1995). According to the Commission of European Communities (1999), the success or failure in adapting to business process re-engineering and change "*depends significantly on the willingness of employees to adapt to this such change*".

Resistance to change has been identified as a major barrier to the success of business process re-engineering. Lack of awareness and understanding, lack of skills, group norms, established traditions, Politics-defending positions preserving powers have been identified as some of the main reasons for resistance to change (Burnes, 1992).

Cooper and Markus (1995) describe a business process re-engineering initiative in a Japanese factory. The analysis of the case study shows that 'human re-engineering' is a viable alternative to business process re-engineering as a strategy for bringing dramatic performance improvements. By involving managers and workers in the change process and by allowing them to express their own ideas about the change, the company succeeded in creating significant improvements in processes and overall performance. Furthermore, no resistance to change was reported due to the fact that the managers and the employees were responsible for suggesting new ideas. Therefore, these changes were not resisted but embraced.

Unlike the Japanese who have embedded the philosophy of quality control circles and teamworking in their organisational culture, western companies seem to ignore the importance of human factors (Imai, 1986). The human resource aspects are quite often considered as an after thought in the re-engineering effort. Consequently, many BPR projects have failed because of the human element.

Within this context the role of leadership is crucial. Doherty and Mistry, (1996) have conducted interviews with BPR consultants in twenty six consulting firms. The results show that one important positive precondition in business process re-engineering is commitment from senior management.

BPR success is significantly higher when all the senior managers are *"totally and visibly committed to the re-engineering effort"*. Senior management typically demonstrates their commitment by being visibly involved with the project.

The use of teamworking is also important. Business process re-engineering signals the rise of teams which will enable change. The findings of a survey involving sixty five organisations, which have re-engineered their processes, indicated the critical importance of introducing teamwork to the re-engineering process (Braganza, 1993).

No one can bring about the change alone (Burnes, 1993). Consequently, team working provides the foundation on which a process oriented organisation responds to its rapidly changing environment. (Aghassi, 1997). The organisation's ability to

form cross-functional and multidisciplinary teams who share the new business vision and have all the skills and competencies to support the new processes is a critical success factor in the re-engineering process.

2.4 The criticisms of Business Process Re-engineering

While business process re-engineering (BPR) has become an often-suggested solution for achieving sustainable business competitiveness, not all attempts have proved to be successful. Some empirical studies show that, although BPR has led to dramatic improvements in time, costs and quality, the overall results for a business unit or an entire company in terms of profit are sometimes disappointing (Hall et al, 1993). Hammer and Champy in 'Re-engineering the Corporation' mention that 70% of BPR initiatives have failed. They claim that:

> *" many companies that begin re-engineering don't succeed with it. They end their efforts precisely where they began, making no significant changes, achieving no step-change performance improvement, and fuelling employee cynicism with yet another ineffective business improvement program".*

Doherty and Mistry (1996) confirm that 70% of BPR projects fail indicating the main reasons for failure as the lack of sustained management commitment and leadership, unrealistic scope and expectations and resistance to change. Also, Coulson-Thomas (1997) point out that "*re-engineering can be risky and should not be undertaken lightly*". He suggests that an organisation has to clarify its motives and strategy before getting involved in a BPR exercise.

Some writers are very concerned with the great hype that has surrounded BPR, because it could disguise a lack of substance (Jones, 1994). There are many contradictions associated with the term which are addressed in the first research theme of the current thesis (chapter, 3 research questions). These contradictions such as incremental versus radical, process-led versus IT led, universal versus specific etc led to the unreliability of the term which created confusion not only around the use

of BPR as a management tool but also around the significance of the concept itself (Jones, 1984).

As it has been discussed in the literature so far there is a debate among academics and practitioners regarding the nature of BPR. Some advocates of the radical nature of the term claim that business process re-engineering has started as a radical improvement of business processes and it has to continue as such. Otherwise, BPR has the same objectives and uses the same methods as other management concepts such as total quality management. On the other hand, there are some academics and practitioners who suggest a more incremental approach to BPR. Their approach is mainly based on the high rate of failure of BPR projects due to radical implementation (Jones, 2984).

A further contradiction refers to the drivers of the re-engineering effort. Hammer and Champy (1993) suggest that business process re-engineering is mainly IT driven, whilst Morris and Brandon (1993) highlight the importance of business processes as opposed to emphasising the impact of IT.

Business Process Re-engineering is also criticised because of its approaches to organisations and people. The advocates of BPR often consider organisations as machines. According to Grint and Willcocks (1995), the re-engineering approach has "*a mechanistic almost seventeenth century view of how organisations function and can be changed; if the clock is broken, replace it with a new one*". Other writers point out that the fundamental organisational change proposed and supported by BPR is missing one very important ingredient: the human factor (Oram and Welling, 1995).

Given this state of the current debate and criticisms of BPR, many researchers seem to be unclear regarding the development of the concept (Davenport and Stoddard, 1994). Has reengineering reached a phase of decline? Is it about to disappear? Is BPR just another management fad, or is a it more serious concept? Is it going to be further developed based on the lessons learnt? The current thinking shows that reengineering is little by little integrated as a change method and is already discussed from a strategic planning point of view. Talwar(1993), for

example, suggests a strategic approach to re-engineering and defines it as "*a strategy-driven, top-down reappraisal and redesign of the total business*". Finally, there is some evidence in the literature that BPR advocates have learnt from past failures and started taking into consideration people related issues such as organisational culture which has proved to be a major inhibitor to re-engineering progress among US and European companies (Oram and Wellins, 1995).

2.5 Conclusions

Addressing the question whether or not BPR is about to disappear, the most well known researchers and authors of the subject suggest that BPR is not over yet. It may continue and build on lessons learnt which means that it has to take a more holistic form taking into account human and organisational issues such as organisational strategy, organisational culture, and resistance to change. Although there are many contradictions related with BPR, modern organisations seem to have a continuous interest in undertaking re-engineering initiatives. As a result, the main objective of the current thesis is related to the clarification of BPR and its successful implementation. The following chapter will present and discuss these objectives analysing the main research themes of the current study.

Chapter 3
Research questions

This chapter gives an overview of the construction sector identifying its major weaknesses and limitations. The chapter also presents the research questions of the current thesis, which will be explored and addressed in the following chapters highlighting the importance of this research.

3.1 Introduction

Research and practice in the construction industry sector during the 1990s have opened a variety of avenues for exploring the issue of business process re-engineering in order to improve construction firms' effectiveness within the context of high pressure due to industry client's, global competition and organisational innovation. However, the 'lessons learnt', coming from practical experience, show that the credibility and the effectiveness of change and improvement efforts in construction such as business process re-engineering is not as simple and straightforward as it may appear.

This chapter presents the current situation of the construction industry identifying its main weaknesses. This identification serves as a basis for the formulation of the research questions that the current thesis is trying to address highlighting the importance of the research. These questions will be addressed in the following chapters and especially in chapter 9 (conclusions and synthesis of results).

3.2 The construction sector in Europe

According to a report produced by the Commission of the European Communities (1997a), the construction industry is the largest industrial sector ahead of the food and chemical industries. Although there was a recession period from 1970 to 1985, when the productivity in the construction sector only increased at an average annual rate of 0.9% compared to 2.3% for all other industries, it is currently one of the most important supply sectors to public purchasers in Europe and is the

largest sector in terms of employment, providing jobs for 8.8 million people (Commission of the European Communities, 1997a). According to the SECTEUR study (Commission of the European Communities, 1997b), every job created in the construction sector generates two further jobs in related sectors. Furthermore, the construction sector has specific characteristics which make it different from other industries:

- it is a heterogeneous and fragmented sector which depends on a large number of very different professions;
- construction is one of the most geographically dispersed sectors with marked regional differences;
- most construction projects are prototypes;
- the final product is one of the few non-transportable industrial products, adaptable to a variety of uses and representing one of the most durable human artefacts. It forms the physical infrastructure for living and working, for production and transportation and for essential services. Half of construction projects relate to renovation;
- investments in machinery, tools and other elements have to be depreciated over a shorter period than is usual for other industrial sectors;
- the entry-level for new contractors is relatively low because the need for operational capital is small;
- it is closely linked to the economic cycle, and being generally conducted outdoors, is affected by seasonal variations;
- the sector is very labour intensive with high mobility of the workforce and growing skills needs as construction technology becomes more sophisticated;
- finally the sector generates an enormous quantity of construction waste and demolition material;

After having analysed the current characteristics of the construction industry, it is essential to examine the factors that determine the competitiveness of the sector and lead to the need for organisational change and transformation. These factors along with the major weaknesses of the construction sector are presented in the following section.

3.3 Rethinking construction

In our 'globally networked society' advanced technological developments have changed the organisational environment which is characterised by increasing complexity and insecurity. Competition and rapid technological changes have put intense strain on many organisations (Hammer and Champy, 1993). The implication is that organisations which are not responsive to changes in the environment will miss business opportunities (Uwakweh, 1996). The construction industry, which is a major constituent of the European Union's economy, could not remain intact by the continuous pressures of the competitive market.

Some of the comments of the Egan report (1998) on the government commissioned investigation into the scope for improvements in the construction industry, focus on the dissatisfaction of the industry's clients, the low profitability, the low investment on research, development and training and the 'under-achieving status' of the whole industry (Egan, 1998). As a result, the attempts to improve the situation in the construction sector through various forms of initiatives such as business process re-engineering have grown over the last decade. The Egan report (1998) highlights the role of IT as a way forward aiming at integrating processes such as product development or project implementation in order to improve decision making, access to information, knowledge sharing and organisational learning and innovation. Also, the Latham report (1994) recognises the importance of the UK construction sector for the UK economy but it points out that the overall performance is problematic and unsuccessful.

In an attempt to enhance the competitiveness of the construction sector, the Commission of the European Communities (1997a) produced a report identifying the key interrelated elements of competitiveness. The first factor is quality which means that there is a need in the construction sector for codes of good practice for all industry participants in order to provide the best service to industry client's. The second factor refers to an assessment of existing markets in which the construction companies are operating in order to overcome the barriers and to cope with high competition. The third factor is related to the construction processes. The Commission of the European Communities (1997a) has pointed out the fact that the construction processes are changing *"by the need to adapt to developments in*

technology and practice". It has also indicated the need for action regarding environmental considerations in the construction sector which can be expressed by, for example, selecting environmental friendly products.

Another critical factor relates to the regulatory framework. According to the Commission of the European Communities (1997a), *"the legal framework surrounding construction remains incomplete since the rules governing works, design, the use of products and liability remain under the responsibility of national authorities."* In addition, the importance of the human resources has been recognised. There is a need for effective health and safety measures as well as training and professional development in order to develop a stable and well educated workforce. Moreover, technology is another crucial factor identified by the Commission of the European Communities (1997a), which can enhance the competitiveness of the construction sector. The technological developments are expected to improve the existing poor dissemination of information and knowledge, which constitute the major barriers to the organisational learning and innovation in the construction sector. The final factor refers to the internationalisation of business strategy. The Commission of the European Communities (1997a) has pointed out that it is essential for the construction companies and especially for SME's to develop closer co-operations and associations among themselves.

3.4 Research themes

The following part presents the three research themes (sections one to three) of the current thesis which are built on the identified weaknesses of the construction sector. The first part of each section presents facts from the literature which justify the choice of each research theme and highlight its importance. Each research theme is translated into research questions, which will be explored in the following chapters.

3.4.1 Section One: Business process re-engineering

Having identified the major weaknesses of the construction sector it is now time to explore the role and the usefulness of BPR. According to the Commission of

the European Communities (1997a), the construction process is a critical success factor which will enhance the overall effectiveness of the industry. More specifically, the report highlighted the need *"to explore and encourage new approaches to collaboration between all parties in the construction process, to improve buildability, cost effectiveness, life cycle costs and quality, and feedback from construction experience to design."*

Within this context, the role of business process re-engineering is crucial in order to enhance organisational effectiveness of the construction sector. Although there are many existing BPR methodologies in the literature (a detailed description and a critique of existing methodologies is presented in chapter 7, (practical applications of CONDOR BPR methodology), the failure rate of BPR projects is very high (70%), (Doherty and Mistry, 1996; Hammer and Champy, 1993). The current thesis is aiming at developing an appropriate BPR methodology that will support business process initiative and enhance organisational effectiveness in the construction industry.

As explained in the literature review (chapter 2, literature review), there are many different perspectives on business process re-engineering which include a number of significant contradictions (e.g. radical versus incremental, IT-driven versus Process-driven etc). The current thesis aims to clarify the concept of business process re-engineering through the development of a BPR methodology and its implementation in three construction companies. The above aims can be translated into the following two research questions:

1a) How will the study help to define an appropriate business process re-engineering methodology in order to facilitate the change process and enhance organisational effectiveness?

1b) How will the study help to clarify the concept of business process re-engineering and facilitate its implementation in the construction industry?

3.4.2 Section Two: Business process re-engineering and organisational and human issues

Hillebrandt (1984) argues that it is inappropriate to simply transfer and transplant to the construction sector new management techniques and philosophies used and assessed in other industries. The reason is that construction industry is characterised by some unique features which justify its incompatibility with other industries (Cicmil, 1999).

Moreover, the construction industry consists of project based organisations characterised by pre-determined life span operations, fixed location, and temporary and diverse relationships between internal parts and between the projects and its environment as opposed to the stable and continuous nature of other industries (Cicmil, 1999). These unique features are becoming even more important when a business process re-engineering initiative takes place which is a major change process for the whole organisation.

The literature and 'lessons learnt', arising from best practice, indicate several organisational characteristics such as organisational culture, business strategy etc, as critical success factors for a business process re-engineering initiative. However, the suggested 'universal' successful ways of implementing organisational change do not respond to the special needs of the construction industry because of its unique characteristics (Cicmil, 1999). Given BPR's focus on processes, many authors have highlighted the fact that business process re-engineering failed to recognise the importance of organisational and human issues in the change process (Willmott, 1995; Wellins and Murhy, 1995). Therefore, the second research theme of the current thesis is to identify those organisational and human issues which have an impact on the successful implementation of a business process re-engineering implementation in a construction firm. More specifically, the above observations and conclusions are translated into the following research question which the current thesis will try to address in the rest of the study:

2) What are the major organisational and human issues that affect the successful implementation of a business process re-engineering initiative and organisational change process in a construction firm?

3.4.3 Section three: Evaluation of implementation of business process re-engineering and organisational learning and innovation

Construction companies are project based organisations and as a result the value of the evaluation and dissemination of 'lessons learnt' is crucial and has clearly been identified as a weakness of the sector (Boyd and Robson, 1996). Also, the evaluation of 'lessons learnt' is important throughout the change process because it can impact on the decision making in all the stages of the change and more specifically in a business process re-engineering initiative. As revealed in the literature search, however, the role of evaluation in the implementation of a business process re-engineering initiative has been neglected.

Earl (1994) suggested in the directions for future research that "*both academics and practitioners are likely to be interested in more evaluative research. It would be interesting to examine whether any particular BPR strategy outperforms others. Tests to success are notoriously difficult in the planning arena; a variety of quantitative and qualitative assessments would be required of both the process and outcomes of the strategies*". One objective of the current thesis is, therefore, to identify the impact of evaluation of implementation of business process re-engineering on the change process.

Many studies have identified various problems in the construction industry such as under capitalisation, fragmented organisational structure, poor communications etc. According to Boyd and Robson (1996), many of the problems in the construction sector arise because of its barriers to organisational learning. They have acknowledged the need for creating a tradition of 'learning companies' and more specifically for the construction industry "*an organisation's only sustainable competitive advantage lies in its ability to learn faster than its competitors...to produce world class construction*".

Organisational learning means changes in what the organisation knows and how it acts (Forss et al., 1994). Business process re-engineering is closely linked with the notion of organisational learning. It aims at an ongoing improvement that will enhance the overall organisational effectiveness. Also, BPR is linked with evaluation which is synonymous to feedback. Feedback is the link between organisational performance and change in the knowledge structures.

A number of authors have recognised the importance of the relationship between the capacity for change and improvement and the organisational learning and innovation (Argyris and Shon, 1996) Within this context, organisational learning may lead to innovation which is crucial for every business sector. A further research objective of this thesis, therefore, is to define the role of evaluation of implementation of a business process re-engineering initiative in organisational learning and innovation. The above research objectives can be translated into the following research questions:

3a) Can the evaluation of the implementation of a business process re-engineering process initiative improve the change process in an organisation?

3b) What is the role of evaluation of implementation of a business process re-engineering initiative in innovation and organisational learning?

3.5 Conclusions

The following table (table 3.1) presents a summary of the research objectives. The above research themes and questions will be addressed and discussed as the thesis unfolds. The significance of these themes and questions is to give a focus to the thesis and a position from which learning can begin. In chapter 9 (conclusions and synthesis of results), these research themes and questions will be revisited and further explored further so that the learning that has taken place through both the literature review and the empirical work can be evaluated and conclusions and recommendations made.

➢ Develop an appropriate BPR methodology that will support business process initiatives and enhance organisational effectiveness in the construction industry.
➢ Clarify the concept of business process re-engineering through the development of a BPR methodology and its implementation in three construction companies.
➢ Identify those organisational and human issues which have an impact on the successful implementation of a business process re-engineering implementation in a construction firm.
➢ Identify the impact of evaluation of implementation of business process re-engineering on the change process.
➢ Define the role of evaluation of implementation of a business process re-engineering initiative in organisational learning and innovation.

Table 3.1: Summary of research objectives

Chapter 4
Research methodology and design

This chapter describes the research strategy and the process of data collection of the current thesis. The chapter analyses the quantitative and qualitative research methodology used justifying the choice of the methodological triangulation. It also gives an overview of the instruments used.

4.1 Introduction

Kotler (1988) suggests that effective research involves five steps; defining the problem and research objectives, developing the research plan, collecting the information, analysing the information and presenting the findings. The first two of these issues have been analysed and presented in the previous chapters. This chapter provides an overview on the research methods used and a description of the instruments used. It also presents the strategy and process of data collection and analysis. The remaining chapters of this thesis will attempt to address the last two points.

In developing an appropriate research methodology designed to meet the objectives of this thesis, the following issues will be discussed. The first is to justify the choice of the research methods presenting an overview of the advantages and disadvantages of qualitative and quantitative methods. The second is to present and explain the instruments used to measure qualitative and quantitative data and, finally, to explain the process of data collection.

4.2 Choice of research method: The triangulation technique

In recent years, there has been an ongoing debate regarding the best research methodology. Discussions of qualitative and quantitative paradigms and methods are commonplace in research methodology literature (Quinn Patton, 1990). Many authors have argued forcefully that qualitative methods should replace the dominant quantitative methods. This view has been strongly opposed by the advocates of

quantitative methods. It has been argued that this classification has created an artificial line and given rise to unnecessary conflicts among scientists (Gummeson, 1991).

In addition to this debate, there has been a third camp which strongly argues that the combination of qualitative and quantitative methods is the best methodology mainly because it gives the opportunity to compensate for method weaknesses (Gummeson, 1991).

The research strategy followed in the current thesis is a combination of qualitative and quantitative methods. The qualitative methods involve case studies and interviews; the quantitative research is based on questionnaires. The case study method as defined by Yin (1993) is an empirical inquiry that "*investigates a contemporary phenomenon within its real-life context, addresses a situation in which the boundaries between phenomenon and context are not clearly evident, and uses multiple sources of evidence*".

This method can serve research needs directly by testing relationships between processes and outcomes, presenting the context of the research, testing the hypotheses and the theoretical conceptions and incorporating qualitative and quantitative methods (Gummesson, 1991). According to McNeil (1984), the use of case studies for studying organisations can provide depth of understanding of relevant issues, and is useful for gaining insights and generating propositions. The case study research method does, however, have some weaknesses, as do the other qualitative and quantitative methods. The results of the case study research can be biased as they are based on the perceptions, skills and subjective interpretations of the researcher. The case study research method also lacks measurability, and is time consuming and laborious.

The source of the information provided by interviewing techniques should also be mentioned. Interviews vary from highly structured (representing little more than an orally administered questionnaire); through guided interviews covering certain areas; through in depth non directive interviews in which the interviewer merely sets the stage and encourages the interviewee to talk as freely as possible; to

informal interviews which take the form of a casual conversation (Anastasi,1988). The current thesis is based on conducting guided, in-depth interviews. For the current research purposes, the researcher conducted in-depth interviews with employees from two companies participated in CONDOR using an interview guide (Appendix II). Interviews can provide a framework within which respondents can express their own understandings in their own terms, as opposed to highly structured instruments such as questionnaires and structured interviews which force respondents to fit their own knowledge, experiences and feeling into the researcher's categories (Miles and Huberman, 1984). However, data organisation and analysis can be quite difficult especially in the conversational interview where different information is collected from different people with different questions.

Quantitative data permit the complexities of the world to be broken into parts and assigned numerical values (Kerlinger, 1986). Such data comes from questionnaires, tests, standardised observation instruments, and standardised interviews. To obtain quantitative data it is necessary to be able to categorise the object of interest in ways which facilitate counting. Quantitative data is easily computerised and amenable to statistical analysis (Quinn Patton, 1986). Miller (1994) observes that the obvious benefits associated with quantitative methods are that numbers make comparison easy, and data are easily standardised, visible and amenable to the normal statistical analysis. Quantitative data is less susceptible to subjective interpretation and thus the internal validity can be assessed more easily. Therefore, quantitative methods are appropriate for testing hypotheses, synthesising variables to determine association and generalisability. For the current research purposes a questionnaire was designed (Appendix I) which is presented and analysed in the following section.

It appears from the above analysis that all methods for data collection give rise to both advantages and disadvantages. McGrath et.al, (1982) argued that research should incorporate quantitative and qualitative research methods to obtain the particular strengths each one offers (e.g. qualitative in depth information, quantitative, generalisability). Other authors support this argument suggesting a multi-method approach in research, because qualitative and quantitative research

methods are mutually complementary and they lead to greater confidence in the accuracy of the results (Quinn Patton, 1990).

This approach is known as the *methodological triangulation technique* (Gummesson, 1991). Based on the above argument the triangulation technique is used in the current thesis. Using this research approach, the researcher was able to control the limitations and weaknesses of qualitative and quantitative findings and to integrate questionnaire survey with the flexibility of case studies and interviews. A further reason for choosing the triangulation technique was that European projects, such as CONDOR, where people from different cultural backgrounds and companies with different organisational cultures and structures are involved, are extremely complex, so different kinds of methods are needed to understand the important complex aspects and applications.

4.3 Quantitative Measurement

4.3.1 Survey Instrument

In order to facilitate CONDOR's implementation and devise a BPR strategy , a questionnaire of four main topics was developed (Appendix I). This questionnaire was created by the researcher in order to gather quantitative data. The items were based on concepts taken from workbooks and quantitative research textbooks (Kerlinger, 1986) and from the literature on BPR, business strategy, organisational culture, human resource management and change management (Scott Morton, 1991; Davenport, 1993). As part of the procedure for checking the content validity, the questionnaire was pretested for content validity by representatives of each company who are involved in the BPR strategy. Advice was also obtained from other people knowledgeable in the business process re-engineering field. Using this feedback the questionnaire was further reviewed to eliminate any ambiguity before a final version was issued for pilot testing.

The pilot test of the questionnaire revealed a need for its translation into French for the French company, as the English language could have proven to be an

obstacle for the French employees asked to complete it. Employees in the Swedish company who pretested the questionnaire commented the English language was not a problem. The questionnaire was, however, partly translated into Swedish (focusing on the more complex terminology), in order to facilitate Swedish employees.

The four sections of the questionnaire cover questions regarding:

- Personal information such as company, name of department, tenure etc.
- The use of IT applications in the construction industry
- Perceptions of the company's environment, culture, structure, competition, resistance to change, IT role, human resource's role and company's policy role in enabling change
- Perceptions of the CONDOR project

Most of the items on the questionnaire were presented in a close-ended format in order to facilitate the respondents and the statistical processing. The questionnaire was followed by a covering letter (Appendix I) in which the main purpose of the research was explained, and confidentiality and anonymity were emphasised.

The four sections of the questionnaire have the following titles:

- General Information
- Information Technology and Construction
- Business Environment
- CONDOR Project

The first section of the questionnaire covers topics related to the nature of the respondent's work. The second section explores the use and the role of information technology in the respondents' work and company, as well as the use of electronic document management system. The third section consists of two subsections and covers topics related to the organisational effectiveness, change and other organisational functions such as management commitment, team working etc. Both subsections include questions and statements presented in five-point Likert scale

format and have acceptable psychometric properties (alpha = 0.80 and 0.60 respectively), (Kerlinger, 1986).

The statistical package SPSS (Statistical Package for Social Science) was used to determine the values of Cronbach's Alpha coefficient. The same package was used in order to analyse the quantitative data (Appendix III). A detailed analysis of the quantitative data is given in Chapter 5 (quantitative analysis and results).

4.4 Qualitative measurement

4.4.1 Case studies

According to Yin (1993), the data collection for case studies is based on documentation, administrative and archival records, interviews, direct observations, participant-observation and physical artefacts. For the purpose of developing the case studies, the researcher has decided to use multiple sources of evidence such as annual reports, CONDOR documentation, companies web pages, interviews, archival records and personal observation. Also, Yin (1993) argues that the use of multiple sources of information is essential because it enables case studies to present more complete and reliable accounts of the social issues and processes.

Being part of the CONDOR project the researcher was allowed to have access to the CONDOR server where many reports regarding practices, process and general functions of the participating companies were stored and to conduct interviews with some employees of the participating companies. In addition, the researcher made some field visits to different branches of Kvaerner construction and to the main branch of OTH (DERBI). The aim of such visits was to gather evidence of best practices in the companies in the companies that participated in the survey and case studies.

4.4.2.Interview Guide

According to Quinn Patton (1990), an interview guide is "*a list of questions or issues that are to be explored in the course of the interview. An interview guide is prepared in order to make sure that basically the same information is obtained from a number of people by covering the same material*". Also, Quinn Patton (1990) highlights the fact that "*the interviewer remains free to build a conversation within a particular subject area, to word questions spontaneously, and to establish a conversation style-but with focus on a particular subject that has been predetermined*". The advantage of the interview guide is that it helps the interviewer to plan the questions carefully according to the research objectives. As a result, the interviewer can use the limited time available in an interview more effectively. The interview guide also helps to make interviewing across a number of different people more systematic and comprehensive by defining in advance the issues to be covered and explored. The latter makes the analysis of the qualitative results more understandable and objective.

An Interview guide was developed for the purposes of obtaining qualitative data (Appendix II). The interview guide was designed with the objective of collecting data associated with:

- The role of new Information Technology suggested by CONDOR in enabling change regarding a company's processes
- The role of a company's human resource policy in enabling change
- The role of organisational structure and culture in enabling change
- The management of change

The interview guide consists of three sections. The questions that are included in the first section ask the interviewees to describe the nature of their job and their company and the role of information technology in their everyday operations. The second part consists of questions regarding the use of electronic document management system and of implementation business process re-engineering initiative. Finally, the third section asks the interviewees to comment on

how their company is adapting itself in the new changing environment and the importance of various factors that affected this change.

4.5 Data Collection

During the discussions between the researcher and the representatives of each company about CONDOR BPR strategy, it was agreed to distribute 140 questionnaires. The distribution of the questionnaires was based on the company size and on the number of employees who are using IT in their jobs. All the participants received an envelope, which included a covering letter, the questionnaire, and a stamped addressed envelope.

The first phase of distribution began with 60 questionnaires, which were sent to different branches of Kvaerner Construction in the UK. Due to a poor initial response the researcher decided to repeat the process and release another 60 questionnaires to the same population with a reminder attached. The final response rate was 50% (30 questionnaires). The researcher has sent 40 questionnaires to JMBygg. The first initial response was very poor (10%) so the researcher decided to repeat the process issuing another 40 questionnaires which were sent to the same employees with a reminder attached. The final response rate was 27.5% (11 questionnaires).

The same process took place for DERBI in France. Unfortunately, DERBI experienced many difficulties in obtaining data and, therefore, the researcher didn't receive any completed questionnaires. DERBI was a much smaller company than the other partners and they experienced many difficulties in obtaining any kind of data. Also, the person responsible for the CONDOR project left in the middle of the project which caused many delays regarding the delivery of the work packages and the participation in the research activities. In total, the researcher sent 140 questionnaires to the three participating companies (60 to Kvaerner, 40 to JMBygg and 40 to DERBI). Due to the poor initial response another 140 questionnaires were sent to the same companies. The total number of the returned questionnaires was 41. The researcher suggested sending out more questionnaires with the introduction of

incentives, which was found to affect the response rate. The CONDOR committee rejected the suggestion in one of the CONDOR general meetings.

In order to strengthen the results of the current research according to the methodological triangulation, which was described earlier in this chapter, the researcher conducted twenty interviews. The interview guide was used for the two companies (Kvaerner and JMBygg). Eleven interviews were conducted in different construction sites and branches of Kvaerner within the UK. Nine phone interviews were conducted with employees of JMBygg. The researcher was unable to visit the Swedish company and conduct interviews with the Swedish employees due to cost constraints. The average duration of the interview was 25 minutes and in both cases the interviews were conducted in English. At the beginning of each interview the researcher informed the interviewees about the confidentiality and the anonymity of the results. Also, she briefly explained that the findings would be used only for the purposes of the CONDOR project in which their company participates in and for the purposes of her own research which will lead to a doctoral thesis.

Finally, the analysis of the quantitative and qualitative results will be presented in the following chapters. The researcher considers the size of the sample to be one of the major limitations of the current thesis which affects the reliability of the research results. A further discussion will be presented in the final chapter (Chapter 9, Conclusions and synthesis of results).

4.5.1 Selection of the sample

Most of the social scientists argue that the random sampling is the best technique to obtain data. According to Kerlinger (1986), "*a sample drawn at random is unbiased in the sense that no member of the population has any more chance of being selected than any other member*". He continues "*Random sampling is an objective procedure divorced from our own predilections and biases*". The researcher contacted the representatives of each participating company and asked for the names and addresses of the employees from different departments and branches. The representatives of each company produced a list of 300 employees in case of Kvaerner and 120 in case of JMBygg. The researcher was unable to send a copy of the questionnaire to all the employees included in the list due to cost constraints.

From these lists the researcher randomly selected 140 names to which she sent the questionnaires. The researcher has used the same list of people during the second phase of distribution of the questionnaires. Finally, the same procedure was followed for the selection of the employees with whom the researcher conducted the interviews.

4.6 Conclusions

This chapter has discussed several issues regarding the various techniques and methodologies available for conducting a research. An overview of quantitative and qualitative methods and a comparison between them was also presented. Drawing on the strengths and weaknesses of both quantitative and qualitative research methods, the methodological triangulation technique which combines different methodologies was decided to be the most appropriate according to the aims and objectives of the current study. Also, in this chapter the design of the survey instrument and the interview guide was described and analysed. Finally, this chapter presented and discussed the procedure of quantitative and qualitative data collection.

Chapter 5
Quantitative analysis and results

This chapter presents the analysis and the results of the quantitative research. It gives a description and analysis of all the quantitative results arising from the distribution of the questionnaire. The statistical analysis is based on the SPSS (Statistical Package for Social Sciences)

5.1 Introduction

The research strategy of this thesis is based on the combination of quantitative and qualitative research methods. As explained in chapter 4 (research methodology and design) the current thesis has used quantitative methods in order to give an answer to research questions presented in chapter 3 (research questions). This chapter is focused on the quantitative analysis and results of the questionnaire designed and distributed by the researcher to the three participating companies. The procedure of the distribution of the questionnaire as well as its psychometric properties were explained and presented in detail in chapter 4 (research methodology and design).

This chapter aims at giving a comprehensive presentation of the analysis of quantitative results using the statistical package SPSS (Statistical Package for Social Sciences). The printouts of the process of the statistical analysis can be found in the Appendix III and the significance of theses results will be further discussed in the final chapter of the current thesis (chapter 9, conclusions and synthesis of results). The results of quantitative analysis will be used to complement the results of the qualitative analysis which will be presented in the following chapter (chapter 6, qualitative analysis and results).

5.2 Research results

The statistical analysis (using SPPS for Windows95) of the 41 questionnaires returned from KVAERNER and JMBygg revealed some interesting points regarding business process re-engineering and organisational change which are presented in the following section:

5.2.1 Description of the sample

Of all the employees who took part in the research, 17.1 per cent (%) of the respondents work for the IT department, 7.3% for the construction department, 7.3% for the commercial department, 34.1% for the production department, 9.8% for the design department, 9.8% for the planning department and 14.6% for the administration department (Table 5.1). Although this diversity enhances the research results, it doesn't allow the researcher to do more advanced statistical analysis because the sample of each category is very small. It has to be noted here that all the tables of this chapter are based on the SPSS outputs presented in the Appendix III.

Department		**Frequency**	**Percent**	**Valid Percent**
Valid	**IT**	7	17.1	17.1
	Construction	3	7.3	7.3
	Commercial	3	7.3	7.3
	Production	14	34.1	34.1
	Design	4	9.8	9.8
	Planning	4	9.8	9.8
	Administration	6	14.6	14.6
	Total	41	100.0	100.0
Total		41	100.0	

Table 5.1: Department

Figure 5.1 shows the job titles of participants in the two companies. There are 17 different job titles. This variety of jobs and specialities enhance the questionnaire's results.

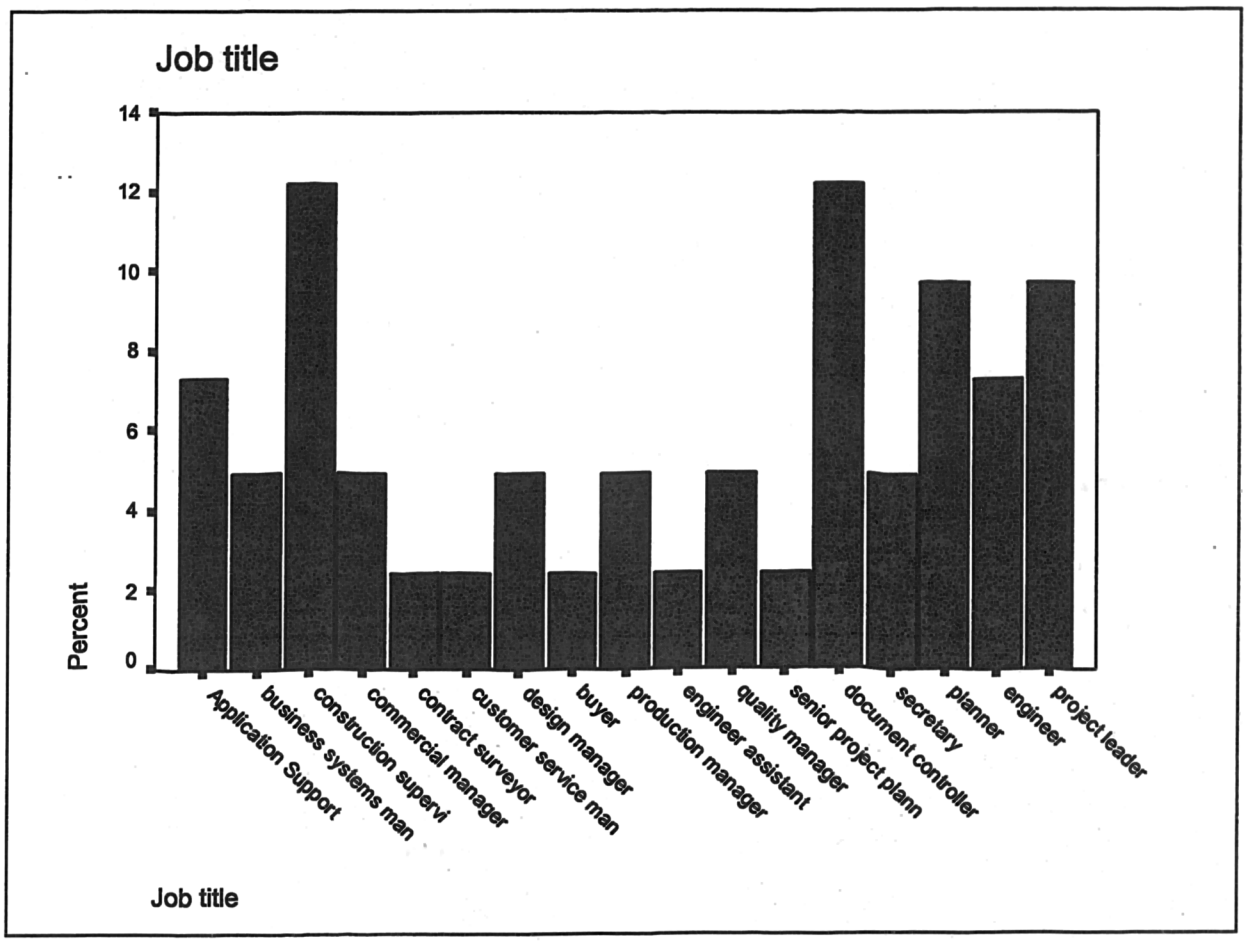


Figure 5.1: Job Titles

Finally, the sample of this research consists of employees who are engaged in different company's projects. The majority of the sample (53.7%) is engaged in one project.

5.2.2 Information Technology and Construction

The second section of the questionnaire is referred to the use of information technology within the participating construction companies. This section of the questionnaire consists of 15 questions (Q2.1-2.15, Appendix I) and aims at identifying the level of information technology skills and knowledge in each company, exploring the role of information technology in the change of day-to-day operations and in the re-engineering process. Moreover, this section is trying to explore the role and the usefulness of the existing electronic document management system as a way of allowing the end users to identify potential weaknesses that will serve as a guide in the re-engineering process. The role and the importance of the following findings will be discussed in chapter 9 (Conclusions and synthesis of results).

Starting with the two first questions of the second section (How many networked computers are there in your company? and How many networked computers are there in your department? Appendix I), the statistical analysis shows that the majority of employees didn't answer either of the questions (2.1 missing values:29 and 2.2 missing values 20). As a result, the researcher withdrew these questions because the statistical analysis is not feasible.

The statistical analysis of question 2.3 (Appendix I) shows that the vast majority of participating employees (97.6%) are using computers in their jobs. In addition, the statistical analysis by company showed that all the employees from JMBygg who participated in the research are using computers in their jobs (100%) and the vast majority of employees in Kvaerner are using computers in their jobs (96.7%). The following table (Table 5.2) shows that the majority of participating employees from both companies have been using computers for a long time. For example, 22% of respondents have been using computers for 10 years and only 4.9% of the employees have been using computers for 2 years.

Number of years		**Frequency**	**Percent**	**Valid Percent**
Valid	**years**	2	4.9	5.0
	1	2	4.9	5.0
	2	2	4.9	5.0
	3	2	4.9	5.0
	4	4	9.8	10.0
	5	2	4.9	5.0
	6	6	14.6	15.0
	8	3	7.3	7.5
	10	9	22.0	22.5
	12	1	2.4	2.5
	13	2	4.9	5.0
	15	3	7.3	7.5
	17	1	2.4	2.5
	18	1	2.4	2.5
	Total	40	97.6	100.0
Missing	**System Missing**	1	2.4	
	Total	1	2.4	
Total		41	100.0	

Table 5.2: Number of years

Comparing the results from the two companies, the average use of computers in JMBygg is 8.7 years and in Kvaerner is 5.0 years (figure 5.2).

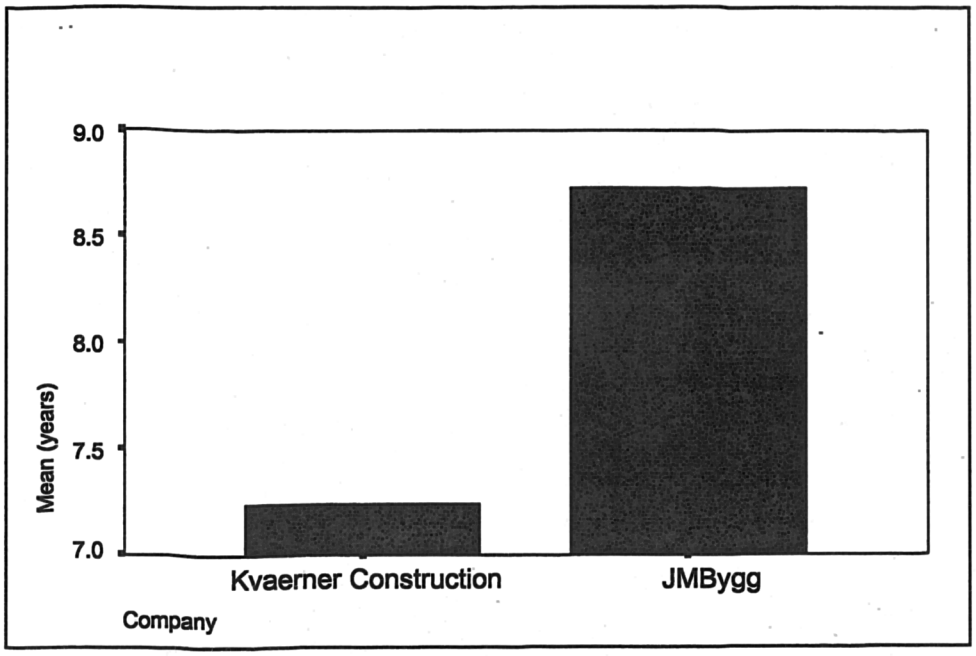


Figure 5.2: Number of years of using computers by company

The following figure (Figure.5.3) shows how comfortable the participating employees feel with using computers. 29.3% of the respondents believe that they are very comfortable with computers, 24.4% of the employees feel neither comfortable nor uncomfortable and 2.4% of the respondents feel that they are not at all comfortable with computers (Appendix III).

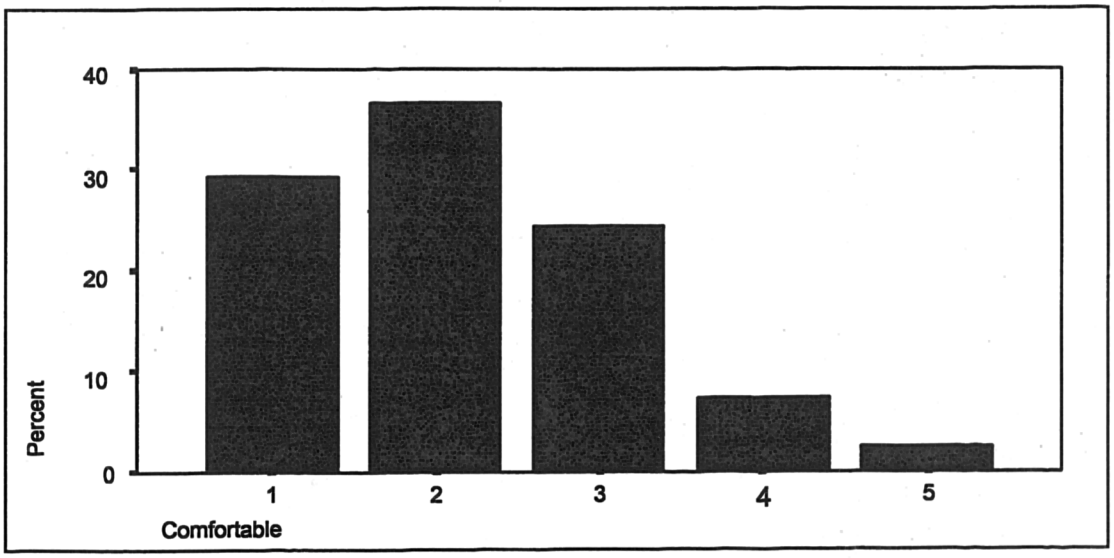


Figure 5.3: How comfortable do you feel using computers?

The statistics for question 2.6 of the questionnaire (Did you have to change the way you worked when you were introduced to computers?) reveal that the majority of the respondents (58.5%) gave a negative answer. Those who gave a negative answer supported this by the fact that they have been using computers for the whole of their working life, so are unable to explain the difference. Those employees who have gave a positive answer to the same question justified their answers with a number of reasons which are presented in the following table (table 5.3):

1. Easier to use
2. Less time consuming
3. Flexibility when changes are required
4. The use of back up
5. No more manual tasks
6. Less errors

Table 5.3: Change in work practices due to the introduction of computers

Regarding the different uses of IT in the participating companies, the majority of employees are using computers for word-processing (87.8%). Moreover, the majority of employees (65.9%) are using e-mail but only 31.7% of the respondents are connected to the Internet. Also, 43.3% of the employees are using their computer for making presentations, 63.4% for spreadsheets and 51.2% for databases. The lowest percentage (2.4%) refers to the use of CAD/CAM. This is an interesting finding given the widespread of CAD systems in construction companies. This percentage should be considered with care due to the sample size. Also, the majority of respondents (78.0%) think that computers make their jobs more effective. The most important reasons are presented in the following table (5.4):

1. Better presentation of work
2. Easier and more efficient information retrieval
3. Easier to spot and correct errors
4. On-line access to information
5. Less time consuming
6. Cost-effective

Table 5.4: Computers and job performance [1]

However, there are some employees (19.5%) who believed that the computers do not make their job more effective. Their reasons are presented in the following table (5.5):

1. Unfriendly system
2. Lack of support
3. Lack of training
4. Time consuming

Table 5.5: Computers and job performance [2]

Question 2.9 (How often do you use your computer?) revealed that the majority of employees (65.9%) use their computers very often (figure 5.4):

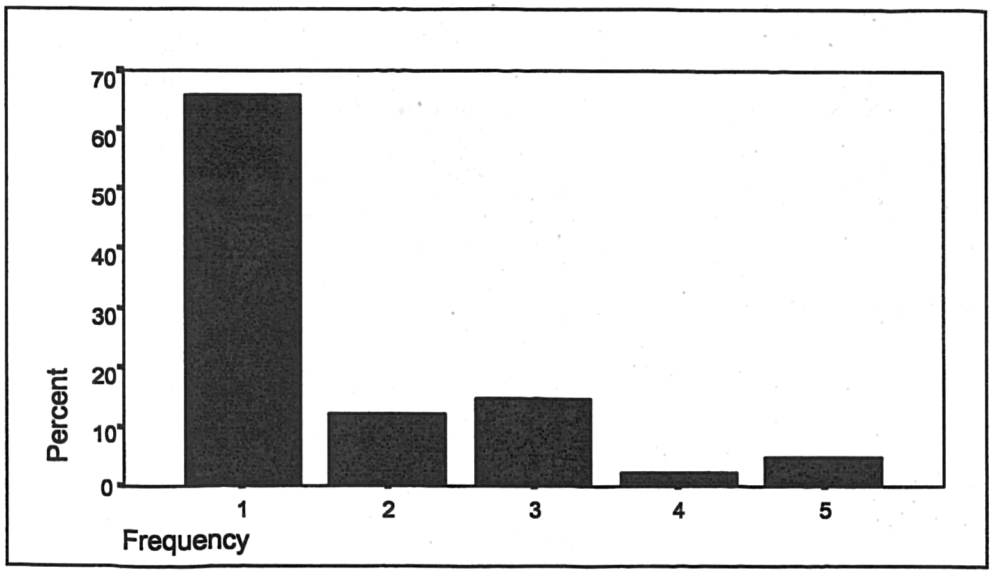


Figure 5.4: How often do you use computers?

The researcher has grouped the participating employees' responses regarding the role of computers in the improvement of existing processes, products and services which are presented in the following table (5.6):

1. time saving
2. improve presentation of work
3. easier production of reports
4. easier tracking of information
5. e-mail -communication improvement
6. transfer of document to colleagues-communication improvement, time saving

Table 5.6: Computers and Improvement of Existing Processes

The majority of participants (80.5%) regularly use a particular software package such as Excel, PowerPoint, Uniplex, MSOffice and Internet Explorer. The statistical analysis of the answers to the question 2.12 (Have you used EDMS before?) showed that the majority of the respondents (53.7%) have not used EDMS before. The following figure (figure 5.5) shows comparative results between the two companies. In JMBygg, 27.3% of the respondents use EDMS and 72.7% of the respondent do not use EDMS. In Kvaerner, 53.3% of the participating employees use EDMS while 46.7% of the respondents gave a negative answer regarding the use of EDMS.

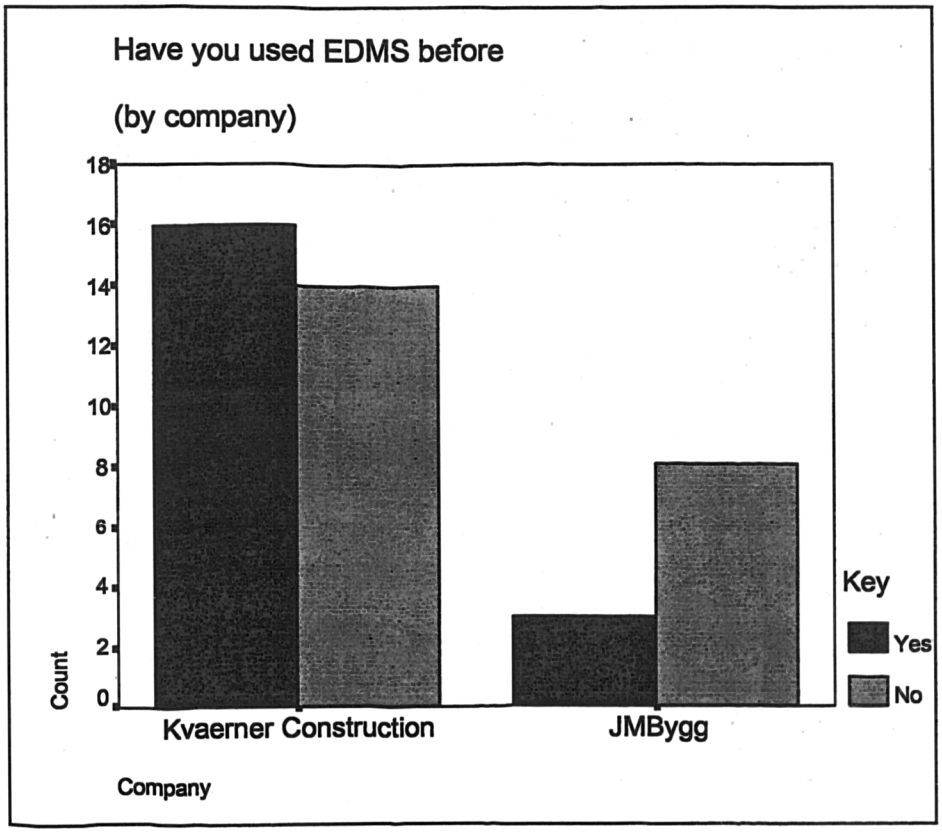


Figure 5.5: Use of EDMS by company

The employees from both companies who have used EDMS before (46.3%), have done so in order to accomplish the following tasks, presented in table 5.7:

1. Drawing issue/register/control
2. Document retrieval and archiving
3. Log in instructions and drawings
4. Graphical presentation of progress of jobs

Table 5.7: Use of EDMS

The majority of employees (53.7%) from both companies believe that the EDMS are useful (Table 5.8). However there is a strong minority (46.3%) who answered negatively regarding the usefulness of EDMS.

Usefulness of EDMS		**Frequency**	**Percent**	**Valid Percent**
Valid	**yes**	22	53.7	53.7
		19	46.3	46.3
	Total	41	100.0	100.0
Total		41	100.0	

Table 5.8: Usefulness of EDMS [1]

The respondents who found that the EDMS are useful for their jobs justified their choice by answering the open question 2.14b (Appendix I). The results are presented in the following table (5.9)

1. Accurate tracking of data
2. Easy to access
3. Reduces paper and amount of photocopying
4. Can locate and manage large quantities of drawings

5. Can be used as database
6. Control flows of information
7. Cost effective
8. Good presentation format
9. Better production of reports

Table 5.9: Usefulness of EDMS [2]

The analysis of the open question 2.15 (What are the main features would you expect from an Electronic Documents Management System?) indicated the main features that the respondents would expect from EDMS. Their answers are grouped and presented in the following table (5.10):

1. Easy to enter information
2. Document search capabilities
3. Simplicity and reliability
4. Interaction between documents and companies
5. Overview facilities of all information generated

Table 5.10: Main features of an EDMS

5.2.3 Business Environment

The third section of the questionnaire referred to the organisational characteristics that can affect the change process (questions 3.1 to 3.3, Appendix I). Employees from both companies were asked to rate their organisation's effectiveness regarding the company's ability to change, the company's investment in new products and services, and the company's policy regarding training and the use of IT.

Regarding the first variable (ability to change) , the 17.1% of the respondents found their company's ability to change very satisfactory, 48.85% of the participants thought that it is satisfactory, 24.4% found the ability to change somewhat satisfactory and the 7.3% of the respondents concluded that their company's ability to change is unsatisfactory. Although there was the optional answer 'excellent' (question 3.1, Appendix I), no one of the respondents marked this answer (figure 5.6).

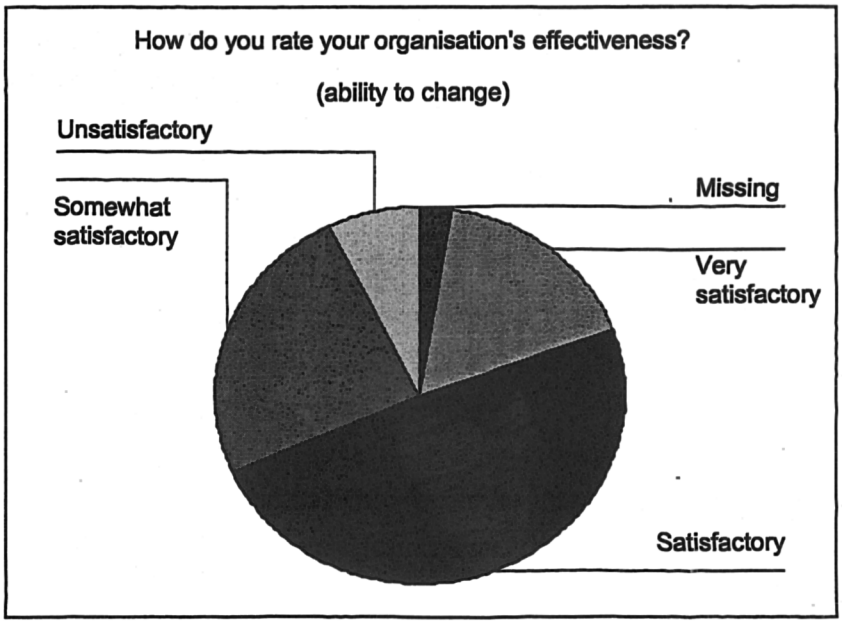


Figure 5.6: Ability to change

With respect to the second variable (business investment in new products and services), 14.6% of the respondents found that their company's investment in products and services is very satisfactory, 51.2% concluded that it is satisfactory, 19.5% of the participants thought that it is somewhat satisfactory and 14.6% found their company's investment unsatisfactory (Figure 5.7). There is no percentage for the fifth optional answer 'excellent'.

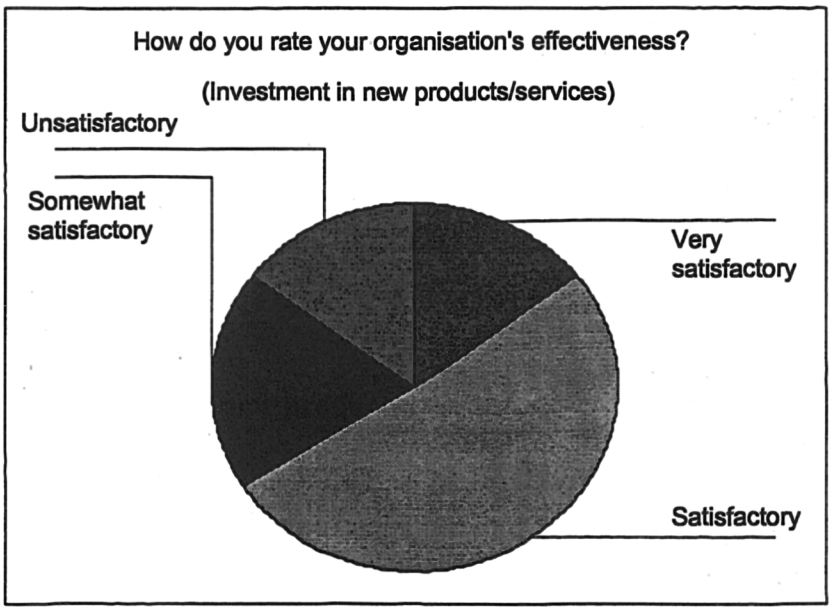


Figure.5.7: Investment in new products and services

The third variable, which is concerned with company's policy regarding training, was found somewhat satisfactory from the majority of employees (31.7%). Also, 19.5% of the respondents concluded that their company's effectiveness with regard to training was very satisfactory, 29.3% thought that it was satisfactory and 19.5% concluded that it was unsatisfactory (Figure.5.8). There is no percentage for the fifth optional answer 'excellent'.

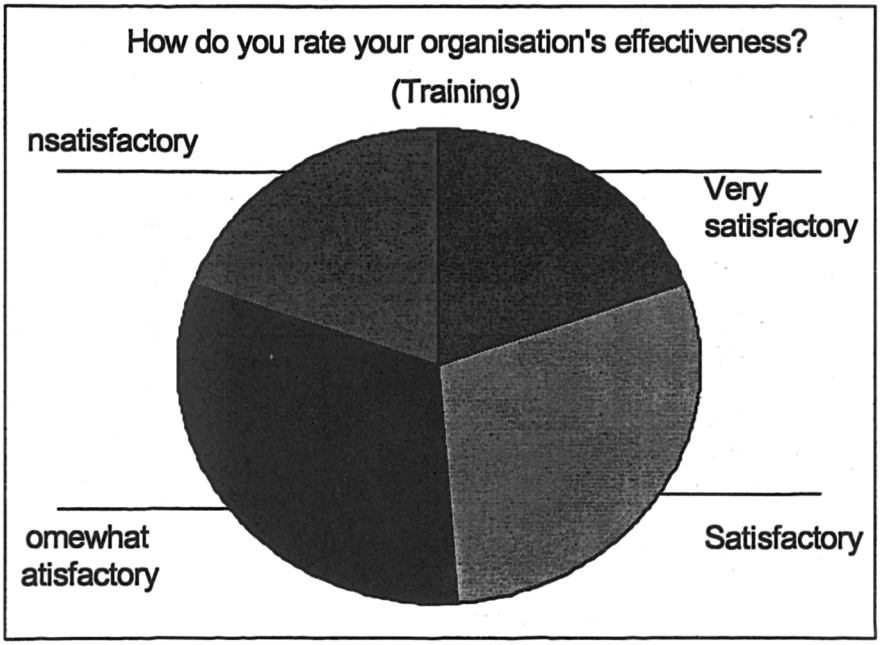


Figure 5.8: Training

Finally, the fourth variable which refers to the use of IT facilities was rated as satisfactory by the majority of respondents (46.3%). Also 2.4% concluded that the use of IT facilities in their company is excellent, 9.8% thought that it is very satisfactory, 24.4% found it somewhat satisfactory and finally, 17.1% concluded that it is unsatisfactory (Figure 5.9)

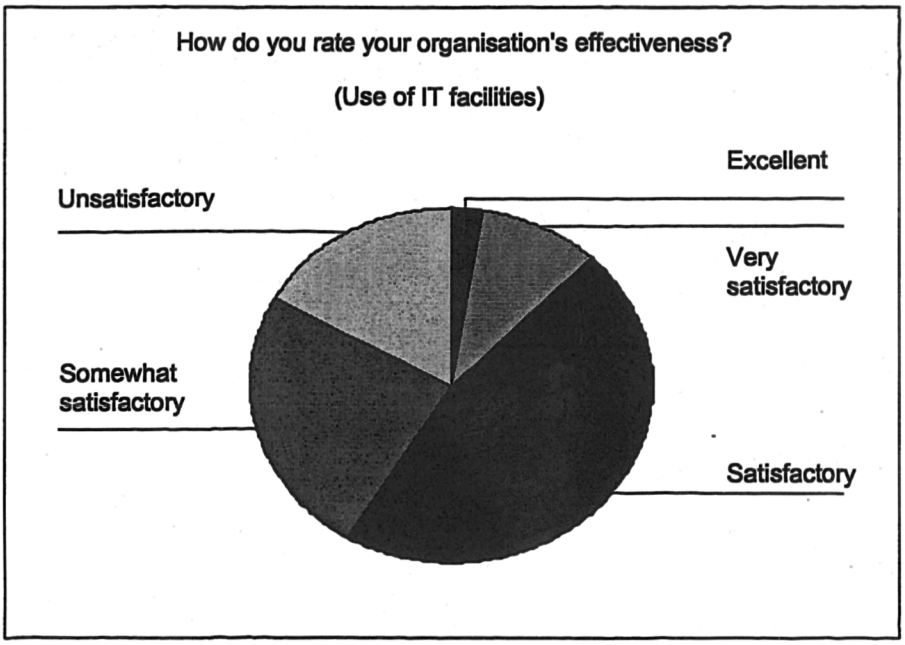


Figure 5.9: Use of IT facilities

The second part of the third section of the questionnaire (question 3.2, Appendix I) asked the employees to rate thirteen factors which were found to have an impact on the change process based on their own working experience in their organisation. The rating started with point one, which means that this factor is not available in the company to point five, which means that this factor is fully in place.

As the following figure (5.10) shows, the ratings of these factors vary according to the responses of the participating employees. The highest rating was given to the factor 'strong leadership and motivation'. The participating employees gave also high ratings to the factors 'communication', 'senior management commitment', team working' and 'project planning'. The lowest ratings were given to the factors 'rewards', 'training' and 'business vision'. The importance of these findings will be discussed in chapter 9 (conclusions and synthesis of results).

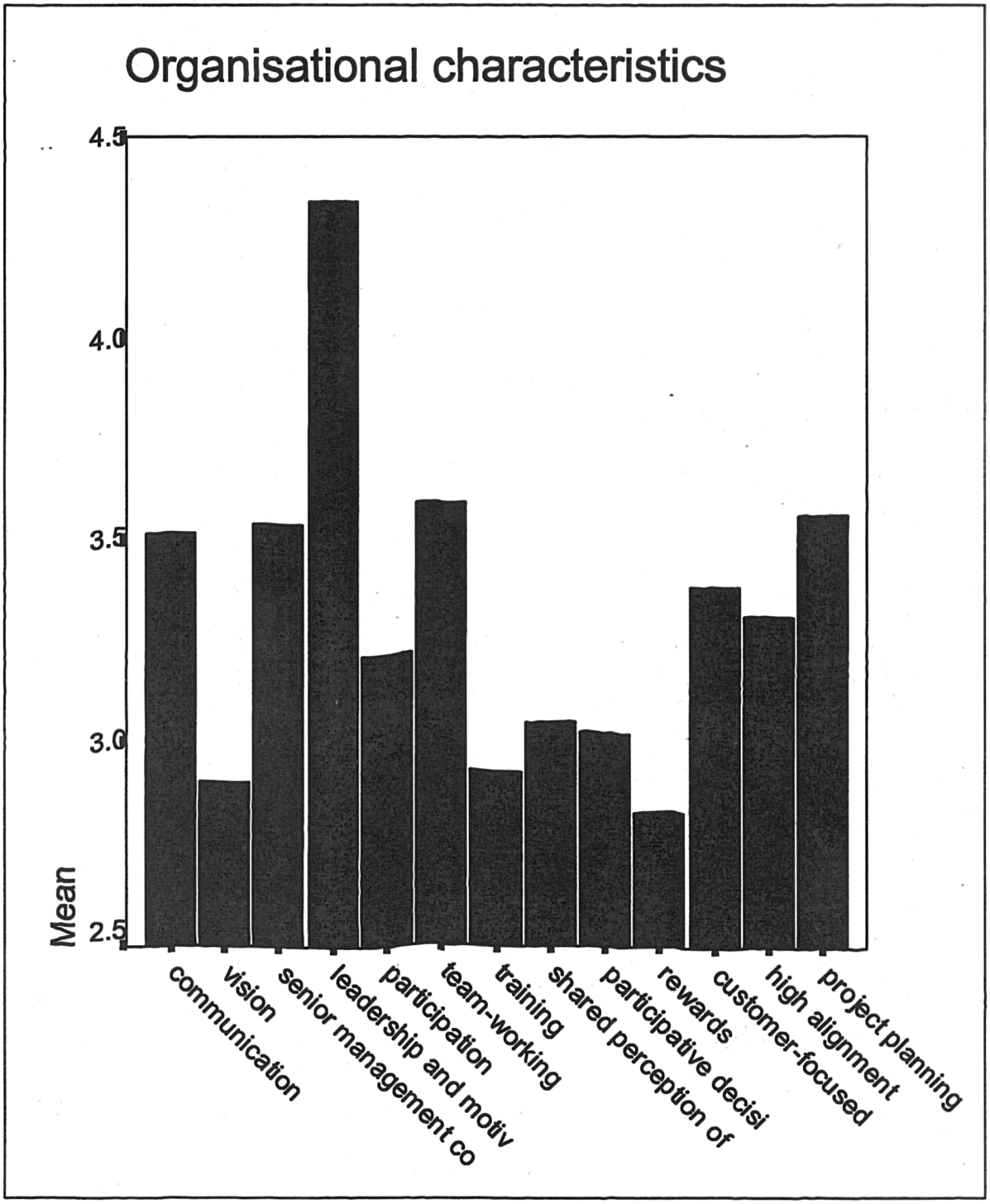


Figure 5.10: Organisational characteristics

The following figure (figure 5.11) shows a comparison between the two companies regarding the ratings of thirteen organisational characteristics. These ratings show that there are many differences between different companies. This finding was expected because each company has a distinctive organisational culture and management style Parfett (1994). Thus, in Kvaerner there is stronger leadership and senior management commitment than in JMBygg. Also, in Kvaerner there is a

stronger emphasis on training than in JMBygg. On the other hand, JMBygg emphasise more on 'communication', 'business vision', 'management-employee participation', 'team working', 'shared perception of the problem', 'participative decision making', 'rewards', 'customer focus', 'high alignment of functional plans and goals' and 'project planning'. The latter finding should be considered with care due to small sample (41 questionnaires) and due to differences in response rates from the two participating companies (50% for Kvaerner and 27.5% for JMBygg).

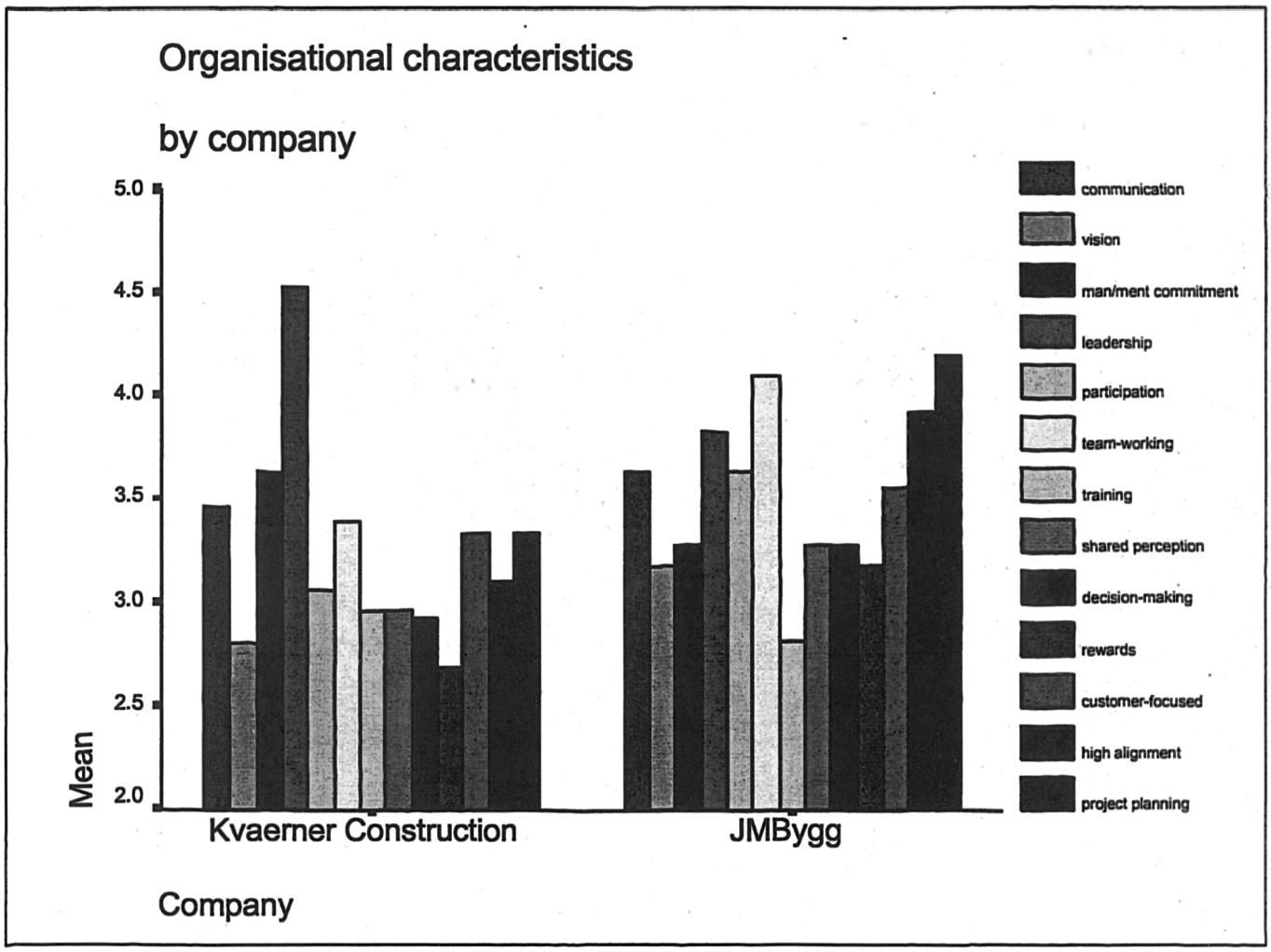


Figure 5.11 Organisational characteristics by company

Finally, the last part of the questionnaire (3.3, Appendix I) was an open question which asked the respondents to identify the main factors that will influence the future growth of their organisation. The content analysis of the answers revealed some interesting findings which will be discussed in chapter 9 (Conclusions and synthesis of results) and they are grouped and presented in the table below (table 5.11).

Competitor development and the competitive nature of the market
Changes in IT
Commitment to change from senior management and from the employees
Obtain new technology
Utilise existing technology
Quality of work
Good management (employee's recognition and motivation)
Employee's participation in decision making
Effective leadership
Client's needs and work availability
Good communication
Training

Table 5.11: Future growth

5.3 The CONDOR project

The fourth section of the questionnaire referred to the perceptions regarding the CONDOR project. The analysis of the results showed that only three respondents were aware of the project. The extremely low rate of positive answers doesn't allow any further statistical analysis. This finding doesn't affect the results of the current thesis because the nature of this section was more related with the CONDOR project. However, this finding is important because it reveals that participation in research projects such as CONDOR is not well explained and publicised in the companies, fact which may affect the dissemination and use of the project's results.

5.4 Conclusions

This chapter has presented a discussion of how this research has addressed the empirical work and the statistical analysis in order to meet the objectives of the current thesis. The statistical analysis of the results revealed some interesting points regarding the use of information technology in the participating construction companies, perceptions on company's role in enabling change and perceptions on

CONDOR project. As mentioned in chapter 4 (research methodology and design), the current thesis is based on the methodological triangulation technique, which is a combination of quantitative and qualitative research methods. Consequently, the following chapter will discuss the qualitative results of the study.

Chapter 6

Qualitative analysis and results

This chapter presents the analysis and results of the qualitative research of the current thesis. The chapter first presents the three participating companies. It then discusses the qualitative findings coming from the in depth interviews.

6.1. Introduction

As explained in chapter 4 (research methodology and results), the current thesis is based on both quantitative and qualitative methodology in an attempt to overcome the weaknesses and limitations of each methodology and meet the objectives of this thesis more effectively. This chapter presents the qualitative analysis and results. Two methods were considered for the qualitative analysis based on the CONDOR project aims and objectives. The first method is based on case study methodology while the second made use of in depth interviews.

In the first part of this chapter, the three participating companies will be presented. The description and the analysis of the case studies is based on information taken from annual reports, CONDOR documentation, companies web pages, interviews, archival records and personal observation. The second section presents the qualitative results of the research that took place within the frame of the CONDOR project.

6.2 Participating companies

As mentioned in the introduction (chapter 1, introduction), the CONDOR project is specifically concerned with defining the working practices, processes, techniques, tools and technical infrastructure to allow the construction industry to

progress from its current position towards a large scale, computer integrated approach (Rezgui, 1998). As such, it is an industry-led project involving

- Industrial partners companies (Kvaerner, JMByggnads and DERBI).
- IT providing companies (CAP GEMINI and Carasoft Software)
- Universities and research organisations (CSTB, University of KTH and University of Salford).

6.2.1 Case study 1: JMByggnads

JMByggnads (JMBygg) is the fifth-largest construction firm in Sweden and one of the larger property management companies in the country. Despite the recession that affected the construction market. JMBygg has managed to maintain a large part of its production because it is the only Swedish construction company that has restricted most of its activities to one particular niche, housing construction. JMBygg has extensive holdings of undeveloped land which are sufficient to construct approximately 10,000 additional permitted buildings and, also, the company is responsible and involved in construction projects in other countries such as Belgium, Portugal and Germany.

JM Byggnads och Fastighets AB (a public company) is a nation-wide construction firm founded in 1945 by master builder John Mattson. The company has been on the A1 list of the Stockholm Stock Exchange since 1982. JMBygg's mission statement is "With every action it takes, JMBygg shall strive to achieve the greatest possible benefit to the customer over the long term."

6.2.1.1 Construction activities

Fifty percent of the company's building production is made up of housing construction for which JMBygg has product and marketing responsibility. As a general principle, the company requires 70 per cent of its the planned flats to be sold prior to the start of construction. Current production is about 1,500 flats per year; only 17 flats remained unsold at the end of 1995.

JM Byggnads AB has three wholly owned subsidiaries: AB Borätt, Seniorgården AB, AB Projektgaranti, and a group of painting companies. The company takes full responsibility from initial design to completion. The customer is invited to participate in the design of his or her home at an early stage by making changes and selecting options.

AB Borätt does not carry out itself any construction work itself, procuring it instead through collaboration with AB Projektgaranti or JM Byggnads AB. Seniorgården AB is organised in the same way as Borätt, but is directed at housing for the elderly. Projects are diverse and include group homes, service flats for the aged and nursing homes, most often in close collaboration with municipal governments. AB Projektgaranti is a construction firm that both undertakes construction and supervises appointed contractors. Design and construction are done in parallel, which minimises construction time. The painting group is made up of three companies: Olle Timblads Målarfirma AB in Stockholm, Miljönären-Lindfeldts Måleri AB in Borlänge, and Gunnarssons Måleri AB in Eskilstuna.

6.2.1.2 Quality and the environment

JMBygg has been devoted to a broad, long-term quality effort since the mid-1980s. In early 1994, JMBygg became one of the first construction firms in Europe to adopt an Environmental Policy that places emphasis on working toward a sustainable environment for nature and human beings.

JMBygg is now requesting materials specifications from all suppliers and subcontractors. This is used to compile a product declaration that lists all the materials used for a JMBygg home, similar to a list of ingredients found on food products. The declaration will be included in a "Home Book" to be given to the customer upon taking residence. The product declaration covers both health and environment-related aspects.

The company has approximately 2,300 employees. Total invoicing in 1994 was SEK 3,875 M. Computer literacy is widespread at JMBygg, but there are several levels of expertise among personnel. A general division into groups is shown on the table below (Table 6.1):

Level of computer knowledge/experience	**Users**	**Percentage**
Provide support for staff including training	Systems Administrators and those with either formal computer training or strong interest in computers	10 per cent
Write and process simple documents	Most office personnel, supervisors	65 per cent
Have marginal knowledge in using computers	Workmen and inexperienced users	25 per cent

Table 6.1: Level of IT skills in JMBygg, Vakola et al. (1998)

6.2.2 Case study 2: Kvaerner

Kvaerner is an international diversified business group registered in Norway and with a London based operational headquarters. The group has more than 54,000 permanent employees worldwide with six core business units (construction, process, oil and gas, shipbuilding and pulp and paper). The company is quoted on the Norwegian stock exchange and has an annual turnover of around US$7B, with the construction division being responsible for around US$1.2B.

The construction division is based in the UK, but derives approximately 60% of its turnover from overseas, especially the Far East and Hong Kong. The division is split into the following business streams: Building, Civil Engineering, International and the Specialist Sub-contractors. The company is one of the five largest main contractors in the UK. Kvaerner is one of the most technically

innovative construction companies in the world with many of the contracts using leading edge techniques to provide modern cost effective solutions.

Kvaerner has invested in research and development over the years both in product development and also in information technology systems to maintain market edge. Kvaerner's aim is to increase turnover in all chosen markets and to be one of the biggest and best suppliers of turn key engineering and construction services in the world. According to the company's mission statement Kvaerner is trying to meet the following objectives:

- To achieve balanced secure growth through co-operation with the clients and professional recommendation.
- To maintain the role of leading building contractor.
- To promote the personal development of staff and at all times to consider their welfare.
- To achieve quality and excellence in all the company's operation

6.2.2.1 Kvaerner Construction Limited

The construction division is based in Rickmansworth, Hertfordshire. These businesses are being further restructured into the business streams mentioned above. For the purposes of the CONDOR project Kvaerner Trollope & Colls (KT&C) will be used as a typically representative company. The latter specialises in high-grade commercial office property development and interiors, predominantly in the London area.

6.2.2.2 Kvaerner Trollope & Colls

KT&C are a London based construction main contractor, which specialise in high quality office and commercial property development and the installation of high quality interiors. KT&C are a well established city builder who have been operating in the area for over 200 years. The business is part of the UK building stream and is separated into two sections: Construction and Interiors.

The majority of KT&C's work is gained by a competitive tendering process. These tenders are received in a number of formats depending on the type of contract. Work is let on the basis of price, quality and program. The contractor then works in general with a professional team to manage the design, procurement and construction of the project. The exact format of each individual contract may vary from one job to another with this being the basic high level format. It is normal for the Kvaerner Construction management companies to allow both internal and external companies the opportunity to price work.

6.2.2.3 Quality, Safety & Environment

The works undertaken by Kvaerner Construction are generally very complex in nature. Kvaerner Construction prides itself in its quality of work and all divisional businesses have had BS5750 / ISO 9000 accreditation since the late 1980's.

6.2.3 Case study 3: OTH (DERBI)

OTH group is a major French engineer firm, specialised in the building process, undertaking large range of tasks for industrial buildings, offices, accommodations, factories, etc. Today, 550 employees work in OTH group for nearly 450 millions FF turnover. It gathers human, hardware, and software resources to perform a wide range of tasks in building process:

- at a technical level : structural and building services (HVAC, plumbing, electricity etc)
- at an administrative level : construction site planning, financial reporting, etc
- at a management level : project management , construction site co-ordination, etc.

DERBI Informatique (DERBI) is a subsidiary of OTH DERBI's annual turnover is 3 M Euro and it employs 20 people. Its main mission is to provide the group with hardware, software, computer networks, and training, to make its engineers more

competitive in performing their daily business processes. To this end, DERBI Informatique has achieved many consulting missions to assist the OTH group subsidiaries in their IT strategy. DERBI is engaged in three main fields of activity

Research, design and development of software applications:

DERBI designs, develops and markets software applications, primarily in the construction domain. These applications include:

- A system for exchanging and sharing documents. This system, called SGT, provides a wide range of functionality for the monitoring and follow-through of all the documentation produced,
- A system for managing the layers composing a CAD drawing,
- A maintenance management program, BATHMAN,
- A system for managing property applications (PATRI and SIP: a Property Information System),
- A cost and quality control product, OSMOSE, designed to optimise the quality/cost ratio for housing projects.

DERBI is also heavily involved in research and development projects, and has participated in several national and EU projects such as innovative internet solutions in construction, development of project management software etc.

DERBI's services cover all or part of the following tasks: analysis of requirements, preparation of specifications, definition of the data processing architecture, establishment of data models, software documentation, testing, implementation, maintenance and training.

Deployment of IT solutions for the production and exchange of data:

DERBI participates actively in organising CAD and computerised communication solutions. This involves changes in the requirements of the design of a production system, in the installation of software and networks, in training and in telephone assistance.

The same services for other types of projects are also provided, including property management operations. These services may be complemented by additional tasks, such as input assistance. DERBI is also an accredited training institution.

Handling of the final co-ordination phase of an operation:
DERBI's services in this field cover the management of the final co-ordination work, conducting site meetings, supervising draftsmen's work, the setting up of an information system for data exchange, and of a production system for the final co-ordination drawings.

6.3 Qualitative analysis and interpretation

According to Quin Patton (1990), the purpose of the qualitative methodology is to produce results. He argues that

> *"the challenge (of qualitative inquiry) is to make sense of massive amounts of data, reduce the volume of information, identify significant patterns, and construct a framework for communicating the essence of what the data reveal".*

As explained in chapter 4 (research methodology and design), the research methodology of the current thesis is based on three case studies and on twenty interviews as part of the qualitative inquiry. Using the interview guide (Appendix II), eleven interviews were conducted in different construction sites and branches of Kvaerner within the UK and nine phone interviews were conducted with employees of JMBygg.

As analysed in chapter 4 (research methodology and design), the interview guide consists of three sections. The questions which are included in the first section asked the interviewees to describe the nature of their job, their company and the role of information technology in their everyday operations. The second part of the interview guide consisted of questions regarding the use of electronic document management systems and of the implementation of business process re-engineering

initiatives. Finally, the third section asked the interviewees to comment on how their company is adapting itself in the new changing environment and the importance of the various factors that affected this change.

The researcher is aware of the fact that "*each qualitative study is unique and therefore the analytical approach used will be unique*" and that "*...qualitative inquiry depends on the skills, training, insights and capabilities of the researcher*" (Quinn Patton, 1990). In an attempt to organise the massive amount of data coming from the qualitative research and the documentation of the CONDOR project (Rezgui, 1998), the researcher has identified, coded, and categorised the data. For the purposes of the analysis and interpretation of qualitative results, each section is going to be analysed and presented separately.

6.3.1 Section A :General Information

The analysis of the results indicates that five interviewees from the JMBygg and three interviewees from Kvaerner were senior managers. The sample was computer literate (from 1 year to 15 years of experience in using IT systems) and their jobs were related (partially or mainly) to the use of IT. All the employees of JMBygg commented that their jobs are based on the use of IT and that they feel very comfortable with using information systems. Also, eight employees out of eleven in Kvaerner stated that they feel very comfortable with computers and they have been using computers for a long time. This finding is supported by the quantitative results presented in chapter 5 (Quantitative analysis and results).

Although fifteen employees out of twenty stressed that information technology is the only way forward and that computers have made their jobs more efficient, there was a strong minority (five employees) who preferred paper-based files to electronic documents. They argued that computers are not properly configured and used especially in short-term construction sites.

Questions A3 and A4 from the interview guide (Appendix II) referred to the company operations such as structure, culture, communication process etc. The

purpose of these questions was to help the researcher understand the existing climate in both companies, identify the 'appropriateness' of such a climate for the implementation of the new CONDOR system and realise the new possible organisational requirements as a result of the business process re-engineering initiative.

As far as communication is concerned all the employees in JMBygg use e-mail internally and externally. They argued that the use of e-mail has cut down on the amount of paper and has also facilitated exchange of information. But the majority of interviewees have argued that the face-to-face communication is still very important. On the other hand, employees in Kvaerner are not very familiar with the use of e-mail and it is only recently that they started using it.

In Kvaerner, the majority of the interviewees have pointed out that construction sites are temporary and they follow the life of the project(s). As a result, there are delays in the installation of the required proprietary and commercial information systems and, therefore, some problems with the exchange of documents or drawings.

Several employees have stressed the fact that they work separately. Those who work with EDMS highlighted the fact that the existing system doesn't allow people to work together and co-operate with each other. Therefore, the communication process is centralised. The organisational structure is based on hierarchies although the completion of projects requires the skills and the knowledge of different people such as document controller, architect, surveyor etc. However, one senior manager from Kvaerner pointed out that the existing situation is changing and that there is a growing need for effective teamworking. In addition, the senior manager informed the researcher that Kvaerner has introduced one IT person in all the teams for the whole life of a project.

In JMBygg, multidisciplinary teams are more established, although the communication networks are still centralised. The existing system does not have the capabilities of making the information available to everybody, which affects not only

organisational functions such as decision making but also business processes which have a direct impact on the quality of the outcome.

6.3.2 Section B: Electronic Document Management Systems and Business Process Re-engineering

Regarding the use of Electronic Document Management Systems, seven interviewees out of twenty have already used, and are familiar with EDMS before. The quantitative results have also revealed that the majority of employees are familiar with the use of EDMS (chapter 5, quantitative analysis and results). Most of them argued that EDMS is like an information database. They have described some advantages and disadvantages. The most important advantages were that the EDMS reduce paperwork and they are easy to understand. On the other hand, the interviewees stressed the lack of security and efficiency. For example, some Kvaerner interviewees explained that they use EDMS in order to log in documents but they use post or telephone when they want to exchange documents or other kinds of information. One employee of Kvaerner from a construction site in Scotland commented:

> *"Nobody in the site uses the system because they don't know how to do it. There is no point to log in documents since nobody wants to access them"*

All the employees, including the senior managers, seem to be preoccupied with the day-to-day tasks. Although they had some complaints about the existing document management system such as its lack of reliability and slowness, none of the interviewees has indicated the need for a more advanced system as part of the company's business vision and strategy. Some of the interviewees have highlighted the fact that the existing EDMS needs some minor changes in order to facilitate them in their everyday activities. The lack of understanding of the overall business strategy and the lack of awareness of the business vision led the employees and the senior management team to be reluctant as regards the implementation of a more sophisticated EDMS. The main reason lies in the fact that they can not yet justify a new system that can potentially be more complex than the present one, even if it can give the company an opportunity to be more competitive.

6.3.3 Section C: Change process

With respect to acceptance to change, the majority of employees in Kvaerner stressed that there is a need for training. They suggested that training would help them to start using new systems. Some of them argued that the current training does not cover more than the basic skills and knowledge. As a result, the system is properly installed but the employees don't have the knowledge and skills to use the whole system's potential. Five Kvaerner employees reported that they don't trust computers in general. They said that although the system is installed and ready to be used, they are not prepared to spend time in learning how to use it. The reasons for not trusting and using computers are as follows:

- They do not have appropriate skills and knowledge
- They are afraid of the new system
- They are afraid of change in the department
- They are afraid of losing their job
- They are very busy
- They do not have support from the IT Helpdesk

On the other hand, all the employees in JMBygg who were interviewed indicated that there are many training opportunities in their company regarding the use of new information systems.

As far as organisational structure and communication is concerned, the responses indicated that there is a lack of communication and co-operation between the different departments and between groups of people particularly between IT and business people. Business people have difficulty expressing their needs and requirements and IT professionals do not understand the business objectives and processes. The analysis of the answers of Kvaerner interviewees to question C4 (Appendix I) revealed that IT people initiate and lead the change. But the majority of the interviewees believed that IT people do not take their requirements into consideration and they do not provide the necessary level of support. At JMBygg there is a more collaborative way of working since all the interviewees stressed that they have the opportunity to participate in decision making regarding investment in new information systems.

Moreover, people in the construction industry are used to working separately. Existing systems do not offer the capabilities for, and therefore do not allow, a more collaborative way of working. For example, the employees who are responsible for document management cannot co-operate in a direct and immediate way with the employees who manage the drawings. The management of drawings is based on the structures within a software package such as AUTOCAD. CONDOR suggested applying another organisational structure since the specific package in use is not important. With the semantic linking people can work together and have access to both in drawings and documents. The reaction to this suggestion by CONDOR was positive since people think that there is a need for a more collaborative working method, which can be more effective and less time-consuming

Finally, several employees have pointed out the fact that some processes or parts of their jobs need improvement. The researcher discovered that several interviewees from both companies had many suggestions in mind regarding how their jobs can be improved according to the requirements of not only the specific project in which they are involved but also according to the nature of their task and the needs of the construction site or company. Some Kvaerner interviewees described the fact that they have never been given the opportunity to express their views regarding the possible improvement of the system, despite having complained many times about this to the helpdesk based in the headquarters of the company. The majority of JMBygg interviewees acknowledged the fact that they participate in meetings where they are given a say on the information systems to be adopted.

6.4 Conclusions

This chapter has presented and discussed the qualitative results of the current thesis. The discussion of the results revealed some interesting points regarding the use of EDMS, the re-engineering process and the organisational change. These findings served as a guide during the development and implementation of the CONDOR BPR methodology. The following chapter will present and analyse this methodology highlighting the importance of human and organisational issues involved.

Chapter 7
Practical applications of CONDOR BPR methodology

This chapter presents the proposed CONDOR BPR model, along with its practical application within the project's end-users companies. The chapter first presents a critique of existing BPR methodologies and models. It then details every single stage of the CONDOR BPR model including the project vision and objectives, identification of processes for re-design, implementation of these processes, and their evaluation based on detailed field trials.

7.1 Introduction

The most frequent question asked among BPR practitioners is "what methodology do you follow", or, "what model do you use". BPR consultants are characterised and differentiate themselves by the methodology they apply. Although there are many successful practices and methodologies, many famous BPR authors, including Davenport (1993), argue that process innovation remains more art than science. Furthermore, many authors argue that BPR is a relatively new discipline and area of research and, as a result, the knowledge of the subject is not sufficient to enable methodologies to be defined and developed precisely (Simsion, 1994). Whenever both BPR practitioners and theorists are involved in BPR work within a given business sector, therefore, they have concentrated on principles rather than on prescription. The need for an assessed methodology is crucial, however, not only due to commercial pressures from BPR and IT consultants, but also for the evolution of the field itself. Potential customers need a methodology as an important criterion in selecting the consultant. Consequently, different types of methodologies and models have begun to emerge in response to increasing commercial pressures.

This chapter presents the advantages and disadvantages of using a methodology in the context of BPR. It also provides a critique of existing BPR methodologies, and explains the rationale and the development of the proposed

CONDOR BPR methodology. Finally, the implementation of this model in the three construction companies participating in the CONDOR project is presented.

7.2 What can a methodology offer to the BPR field?

According to Preece and Peppard (1996), a methodology is simply theory put into practice aiming at dealing with real world situations. The use of a methodology is essential for a number of reasons. Firstly, a methodology provides a means of codifying experience, knowledge and ideas, in a form that can not only be easily applied, but also can be evaluated and tested. Secondly, a methodology offers a certain level of organisation, and facilitates planning and monitoring. In BPR initiatives, a methodology enables the organisation, on the one hand, to have a clear picture of its current processes along with their associated problems, and on the other, to design the new state of these processes. In addition, by following a certain methodology, BPR engineers have the opportunity to monitor and evaluate the progress of the re-engineering effort.

Thirdly, a methodology enables those who are involved or affected by the BPR to understand their tasks and clarify their roles. A BPR methodology which is clearly defined and explained to those who are leading the BPR work can facilitate the communication between them, and serve as a kind of 'contract' in which all the parties understand their responsibilities and are therefore able to monitor the overall process re-engineering progress (Simsion, 1994). Finally, adoption of a methodology allows a standard set of required skills to be identified and developed. Key skills required for BPR include process modelling, organisational development techniques, and skills to deal with resistance to change.

There are, however, a number of problems related with the use of a methodology. One important reason which explains the reluctance of developing and using methodologies or models in the BPR context is that the widely accepted methodologies are based on how the business processes should change and how the organisation should adapt itself in this change, rather than on the evaluation of current practices and on the codification of successful practical experiences (Simsion, 1994).

Moreover, the BPR literature search reveals that there are an increasing number of successful re-engineering implementations and case studies using BPR methodologies. Although each business situation has some unique characteristics, an appropriate methodology will need to allow for assessment and re-use of existing successful approaches and practical experiences.

In addition, a methodology hides the danger of restraining creativity and innovation. The latter are crucial elements in the radical thinking during the re-engineering process. By encouraging those who are involved in the re-engineering process to comply with the requirements of a given methodology, there is a potential risk of restricting the opportunity of optimising the results according to the level required by the methodology (Simsion,1994).

In conclusion, there are many advantages and disadvantages regarding the use of a specific methodology or model in the re-engineering initiative. Each side demonstrates equally important arguments that affect the organisation. The alternative to using a methodology in an attempt to minimise the negative consequences is not anarchy but a contingency approach tailored to suit the objectives and needs of every organisation or business sector, building on basic principles of planning and monitoring as well as on previous successful working practices.

7.3 Critique of existing BPR methodologies and models

The are many BPR methodologies and models available, and most of them pursue a similar path and exhibit commonalties in key areas (Butler, 1994). Today, an increasing number of methodologies, models and tools taken from other disciplines are available in the market, claiming that they are suitable for business process re-engineering initiatives. Ruessmann et al (1994) reported the results of their research claiming that BPR methodologies are based on a synthesis of techniques drawn from other disciplines and methodologies such as soft systems, total quality management (TQM), bench marking, and organisational development.

According to a British BPR methodology survey summary findings (Archer, 1996), the number of stages involved in BPR approaches varies greatly, despite the fact that they do present key similarities. This research took place in 48 consultancy firms in the UK. The range was quite large starting with a minimum of three stages and a maximum of eleven. The most popular number of stages was four with an average of five (Figure 7.1):

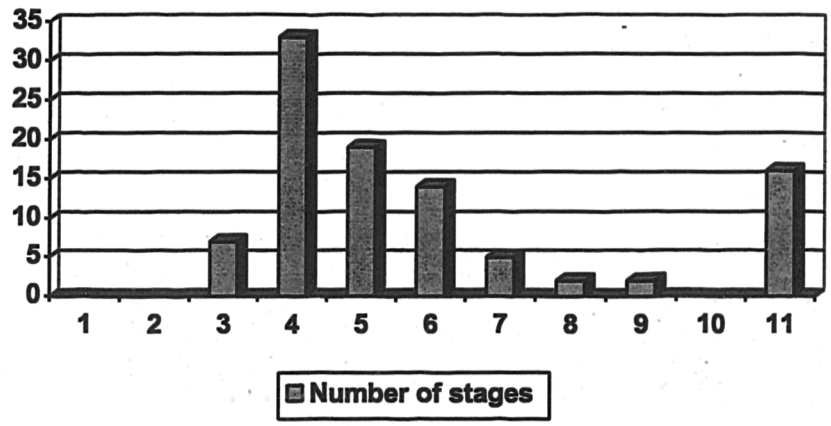


Figure 7.1: Number of Distinct Stages Contained in BPR approach, Archer, 1996

Coopers and Lybrand, a UK consultancy firm, use a four step methodology called SPARKS in order to meet their clients' needs (Ruessmann et al, 1994). They have used this model across forty exercises throughout the world. The four phases are:

- Specify what the process currently is.
- Validate the model of the current process and identify its strengths and weaknesses.
- Test alternative designs and select the best option.
- Implement the process.

Another consultancy firm, Texas Instruments, propose a different model consisting of the following four distinct phases (Ruessmann et al, 1994):

- Initiation and preparation.
- Understanding and diagnosis.
- Redesign.
- Implementation.

Throughout the literature, there are many methodologies and models, which exhibit many commonalties in the key areas such as planning, monitoring and implementation. Another one which is worth mentioning comes also from a research by Ruesmann et al (1994), and is based on the following three key phases:

- Problem structuring and definition.
- Process analysis, diagnosis and redesign.
- Implementation.

From the above numbers, it is apparent that there is a consistent need to understand how 'to conduct' BPR and to apply a type of methodology that can guarantee success. This demand is understandable and does make sense. However, process re-engineering is very complex. It is extremely difficult, if not impossible, to produce standard 'recipes' of success applicable to every business sector. The majority of the methodologies proposed by various academics and practitioners are platitudes attempting to cover the needs of all or as many as possible organisations. Based on the above discussion, along with a thorough examination of the literature facts and of the best practices in various industry sectors, the following comments were raised and served as a guide for the development of the CONDOR BPR generic model.

An important observation is that most of the methodologies stop at the implementation phase, and consequently seem to be quite static. The exclusion of evaluation and the notion of continuous improvement seem to be inconsistent with the increasing pressures of an ever-changing world and from a highly competitive environment.

It is also important to note that while some of these methodologies or models include some 'soft' elements in their approach (recognising the importance of

organisational culture, human relationships and resistance to change), many of the currently available tools focus on the harder and more quantifiable elements of the organisation (Ruesmann et al., 1994). As a result, there are many tools and methods available in order to model, map and redesign the organisational processes but there are no any methods or tools aimed at identifying human and organisational factors that affect the change process. Many papers and best practices recognise the importance of the human element and of the organisational functions (Willcocks and Smith, 1995). However, the latter are often not addressed in the proposed solutions and methodologies, and are therefore not recognised as being an integral part of the organisational change. Consequently, most of the existing methodologies do not include stages related to human and organisational requirements, although they do recognise their importance.

Despite some common principles like planning, monitoring or implementation, it seems that each sector has its own needs and some unique features. What is good for one company may be totally unacceptable to another as many issues including cultural differences, management style, and staff relationships, all impact on the adopted method (Parfett, 1994).

In summary, there are various models and different methodologies regarding business process re-engineering which exhibit similarities in key areas such as planning and implementation, but also many differences, including the continuous improvement stage. The majority of existing methodologies, drawn from techniques and practices within other disciplines, have shown that the human and organisational issues were not incorporated successfully in the proposed methodologies.

7.4 The rationale of the CONDOR BPR model

As is has been suggested above, the critique of existing BPR methodologies served as a basis for the development of the CONDOR BPR model. One of the starting points of this model was the analysis of the characteristics and needs of the construction industry. As mentioned in chapter 3 (research questions), a number of authors argue that it is inappropriate to simply transplant new managerial techniques or methodologies adopted, used, and validated in other industry sectors (for example

manufacturing), to the circumstances of the construction industry (Hillebrand, 1984). According to Cicmil (1999), the incompatibility of construction with other industries lies in the fact that, although construction firms do 'operate' throughout the time, their capacity utilisation and management methods are 'demand driven'. As a result, it is the organisation's project operations that form the basis of its existence and progress. The construction industry as a 'project organisation' is characterised with fixed locations, a pre-determined life span and defined scope as opposed to the relative stability and continuity in existence of the firms in other industries. This unique feature imposes significant challenges to construction firms and highlights the need for continuous improvement.

Every construction project is a temporary multi-organisation characterised by a diversity of internal relationships, as well as by the various interdependencies between the project and its environment (Cicmil, 1999). This complex combination characterises the nature of the overall culture, and affects the nature of decision making, communication, team working and organisational structure. These unique characteristics of the construction sector have affected the development of the CONDOR BPR model by integrating the rationale of evaluation and continuous improvement throughout the eight stages of the model, and by taking into account the organisational characteristics which form a strong basis leading to the identification of change levers during the re-engineering process.

Finally, as it has been mentioned before, a major drawback of some BPR methodologies is that they are not cost effective. This factor is crucial for the successful implementation of the re-engineering process because the companies have to survive in a highly competitive market. Observations from the literature indicate that although the theory behind the development of certain methodologies is well defined, the application of these methodologies is not feasible either due to cost and time limits or due to lack of information of potential savings. The aims and objectives of the current thesis highlight the importance of the cost effectiveness of the applied methodology. This is one of the motivations behind chapter 8 which presents the evaluation of the proposed methodology by the three participating companies.

7.5 A generic model for BPR

A generic model derived from a study of the literature and from an assessment of the best practices and adapted to the CONDOR requirements is presented in Figure 7.2. The model presents BPR as a cycle of successive steps and as an ongoing process (Vakola et al, 1998). The eight proposed stages are as follows:

1) Develop Business Vision and Process Objectives
2) Understand Existing Processes
3) Identify Process for Redesign
4) Identify Change Levers
5) Implement the New Process
6) Make New Process Operational
7) Evaluate the New Process
8) Ongoing Continuous Improvement

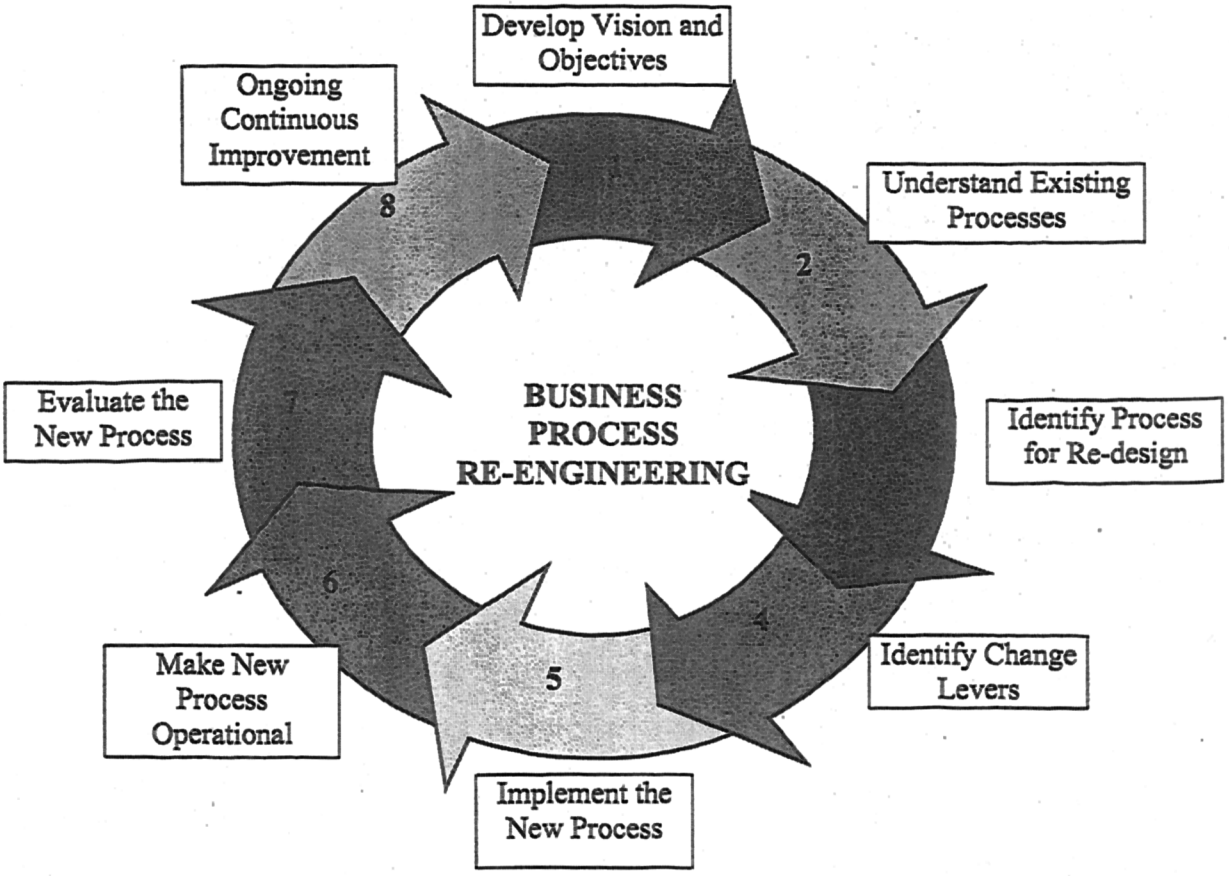


Figure 7.2: A Generic Model for Business Process Re-engineering, Vakola et al., 1998

7.6 Stage 1: Develop business vision and process objectives

The CONDOR project has given a unique opportunity to the project end-users to review their business processes and information management practices, and define a clear IT strategy. Expressing their business vision was not an easy exercise. The CONDOR end-users tended to be very protective, and too close to their work arrangements, and had problems with criticising the IT options, including proprietary and commercial systems, which they had themselves recommended in the very recent past. The research team had to face a double challenge: on the one hand, to express a business vision sufficiently generic to be shared and agreed upon by all the partners; and, on the other, to ensure the relevance and adequacy of this vision to the peculiarities of each company involved, throughout the CONDOR project lifecycle. As an illustration of this, the vision expressed while writing the CONDOR proposal had to be revised when the project started. This was due mainly to the advances made in IT within this lapse of time (18 months). Therefore, the project co-ordination team had to constantly adapt to the very changing process and business environment of the end-users.

The first CONDOR BPR stage refers to the development of vision and objectives. The CONDOR end-users had to evaluate their current practices, prioritise their objectives, and set up targets. Developing a business vision and process objectives relies, on the one hand, on a clear understanding of organisational strengths, weaknesses and market structure, and, on the other, on awareness and knowledge about innovative activities undertaken by competitors and other organisations. Therefore, the external forces (customer needs, competitor actions, technological and environmental factors) and internal factors (assessment of internal capabilities), influence the formulation of the business strategy which in turn determines the process objectives. This stage is very important because organisations tend to embrace the need for radical change only when there are significant external threats or market pressures.

The end-users involved in the CONDOR project have realised the need to promote, deploy, and make an effective use of information and communication technologies within their companies. This was regarded as an enabling means to re-

engineer their business processes in order to achieve sustainable business competitiveness. The development of the project business vision was based on the analysis of competitive forces affecting each company in a different way, as well as on the inspection of the state of the organisation (its performance, resources, culture, etc.). Although the project end-users presented many differences, including size and company resources, their business vision is based on the use of IT as the best way of transforming and improving their business processes.

Moreover, all the project end-users have acknowledged the fact that effective information management can play a determining role, and can contribute to the success of their businesses. Information is regarded as power. They strongly believe that effective use of information can potentially empower their organisation, and allow it to gain more market places and remain competitive.

Therefore, moving from processes and information management practices based on the current paper document-centred approach, to processes based on a pro-active model-based approach (making use of integrated databases) is the key issue in facing the ever-growing complexity of construction projects. The end-users have acknowledged that most of today's commercially available solutions are considered to be unsuitable for the particular requirements of their industry, which involves virtual teams being brought together for projects and broken apart on completion. This context of virtual teams means that it is important to accommodate the diversity of the teams and individuals collaborating on projects by developing low entry level tools for SMEs (cheap and user-friendly) and providing solutions that promote the integration of existing legacy, proprietary, and commercial systems used by actors.

The end-users, therefore, expressed a strong need to enable dissimilar electronic document management solutions to co-exist within the same project. The CONDOR end-users were found to be reluctant to use proprietary systems developed by other organizations, within their projects, as indicated in Vakola et al. (1998). This is due mainly to their investment in their own system, and also to the impact of the adoption of these systems in terms of training and cultural change within their organisations, which is likely to be a costly and time-consuming process. Therefore, the consortium members have chosen not to develop a unique

document management solution for all project partners, mainly for the following three reasons:

- the CONDOR end-users have invested several years of work in developing and improving their legacy EDM systems. The idea of developing a new system seemed to have created fears and strong reluctance within the IT department of the companies in question;
- the functionality of these EDM systems provide support for some basic form of work flow. This functionality is, in some cases, company specific, and, therefore, not required by the other end-users;
- from an IT perspective, given the latest progress made in the area of open system architecture and distributed object technology, it was more natural to adopt an approach that promotes an integration of the existing legacy systems.

The CONDOR Consortium has chosen, therefore, to promote the use of the various existing legacy systems as opposed to developing a new EDM solution.

Each of the construction industry partners, that constitute the three case studies for the current thesis, is already involved in making significant improvements to its processes through the use of integrated information and communication technologies. They are all now involved in extending the benefits of such improvements across all functional areas and all divisions of their companies with the aim of making significant reductions in costs and improvements in quality. Their participation in projects such as CONDOR and the co-operation with partners from other countries show that construction companies face similar challenges in a continually changing environment and that their business strategies exhibit commonalties in key areas.

The overall project vision was described in chapter 1 (introduction). The objectives that support this vision include the following (Rezgui, 1998):

- Provide opportunities for new processes and new forms of project organizations to be used on construction projects.

- Demonstrate the potential to reduce time in every part of the construction process (planning, designing and production) by 20%.
- Improve document quality and consistency throughout the project.
- Increase accessibility of project information to all participants in the process, and allow small to medium sized enterprises to be more closely integrated into construction projects.
- Define the process changes required in order to realize the benefits of integrated document management.
- Identify organizational and cultural issues impacting on the adoption of integrated document management and propose ways of addressing these.
- Integrate document based ("black-box") and model based approaches to project information management.
- Provide a migration path and strategy for moving from document-based to model-based approaches. Integrate more closely document types and representations, (e.g. text and drawing).

The above objectives were obtained, on a consensus basis, from brainstorming sessions of several hours involving all the CONDOR partners. They were based on end-users specific objectives. In some cases, the proposed cost savings, and time reduction figures, have been revised in order to reflect what was feasible, at the time, within the proposed duration of the CONDOR project. The following sub-sections describe the overall climate, as well as the level of IT support for business processes (including document management practices), within the end-user companies prior to the start of CONDOR.

7.6.1 Case study1 : JMByggnads AB

JMBygg is one of Sweden's largest property and building companies. JMBygg was, and still is currently, one of the pioneering users of EDM systems in the construction industry. They have started using a functioning document handling system, initially in one of their Stockholm departments, as early as the beginning of the 1990s. All documents produced internally, including drawings, were stored and structured by project in a company database. Several workplaces were then connected to this shared database via ISDN links, as were also external consultants

and specific suppliers. JMBygg then went through a phase of spreading the system and the associated working methods throughout their entire company.

At the time of preparation of the CONDOR proposal, JMBygg had set an ambitious target to reduce administrative costs by 50% and total project costs, including project management, by 20%. To meet this ambitious objective JMBygg was planning to develop a more advanced and intelligent document handling system, and other associated tools. Previously implemented development projects in this field have given JMBygg a leading position in the Swedish building sector. This emphasises the importance of research and development projects, such as CONDOR, for JMBygg.

7.6.2 Case study 2 : Kvaerner

Kvaerner started implementing an IT strategy which mainly covered administrative systems, the next phase which covered site based operation was due to commence a year after the start of CONDOR. These developments were part of an overall business strategy devised at the company level. One of Kvaerner's major objectives at the time was to reduce overall project costs, as part of the requirements of the Latham report (1994) published in the UK. The target set by the Latham Report is to reduce the overall construction cost by 30%.

The initial EDM system used by Kvaerner was referred to as a document control system. It originated as part of the 1989 Trafalgar House Construction IT strategy. The development was carried out in house using third party modules such as document viewers and index engines. It was expected that the system would significantly reduce the time taken to transmit documentation between the design offices and construction site, and the period of time required to complete a review and comment cycle. The benefits expected by Kvaerner through their involvement in the CONDOR project include the following:

- Enable rapid response to technical and construction problems as they arise, and impose accountability for actions.
- Build a complete audit trail of all documentation.
- Have on line access to archive data during the project.

- Significantly reduce the number of hard copy prints.
- Shorten the communication time between various parties in resolving outstanding issues.
- Enable team building between professional teams and sub-contractors.

The intention at the time was to set up an electronic document hub for all parties to pass and distribute documentation by making use of advanced electronic modes of data transmission, and Internet e-mail.

7.6.3. Case study 3 : DERBI

One of the major themes tackled by DERBI during the preparation of the CONDOR proposal was related to data exchange, and support for improved communication between partners from heterogeneous disciplines using a variety of construction industry standard tools. With regard to document management, one of DERBI's main objectives was to put in place a new kind of electronic service to improve the way contractors share documents, and to enable them to make available to others their own skills, added value, and know-how. For this reason, DERBI developed in the early 1990s a robust document management system that was used by contractors for receiving, sending, making available, and storing documents of all types, within both a project team and the entire organisation. The system made use of a client-server architecture through which project participants were given access to a shared database. This database contains the entire documentation used on projects, including drawings and Full Specification documents.

This document management system was one of the most advanced applications in the construction field in France. However, DERBI was looking forward at that time to further developments to the SGT system, aiming at the semantic control of the information contained within documents. So far, all documents stored on the SGT server were treated as black boxes. The SGT users expressed strong demands to provide better control of documents' semantics in order to support intelligent queries of building-related information. DERBI were hoping that the CONDOR project would provide their system with the needed functionality to sustain their leading market position in France. In addition, they were eager to provide their project end-users with a platform that would not only promote

document sharing, but also provide support to some form of basic workflow through a wide range of dedicated functionality.

7.7 Stage 2: Understand existing processes

Understanding business processes has become very important in today's business environment (Scott Morton, 1991). It is even more important to understand existing processes before designing new ones. Recognising problems in an existing process can help ensure that they are not repeated in the new process. Understanding existing processes also facilitates communication among participants in the BPR work. Models and documentation of current processes enable those involved in the BPR initiative to develop and share a common understanding of the existing state.

The CONDOR end-users have analyzed and described their business processes and document management practices. This overall analysis revealed that present document management practices in the construction industry are carried out in an ad hoc way, and rely to a large extent on manual methods. In fact, even if most documentation is produced using computers, it is still exchanged on a paper-based medium. Electronic document management systems are being introduced gradually into the end-users' companies, and across their different departments, much like CAD was introduced about two decades ago. Despite some minor differences, the EDM systems belonging to the CONDOR end-users offer similarities across organisational boundaries. An example of this exists in document categorisation, archiving, retrieval, versioning and approval. The services provided by these EDM systems are being used as a basis for the definition of the CONDOR services that will support inter-working between these legacy applications.

7.7.1 Document management practices in JMBygg

JMBygg use a document management system called Eureka!Filebase that enables the storing and retrieval of documents, including text and drawing documents. Eureka!Filebase supports document history, administers the maintenance of file revisions, and stores documents according to a unique registration. It is used on JMBygg's construction projects. The various actors

involved in the design and build process, including engineering teams, the project management team, consultants, and individual suppliers, are given access to a shared database containing the entire project documentation through Eureka!Filebase client software, as indicated in figure 7.3. The overall system is PC-based. It is used within the offices of both JMBygg and the project participants. The shared database is accessed via dedicated ISDN links.

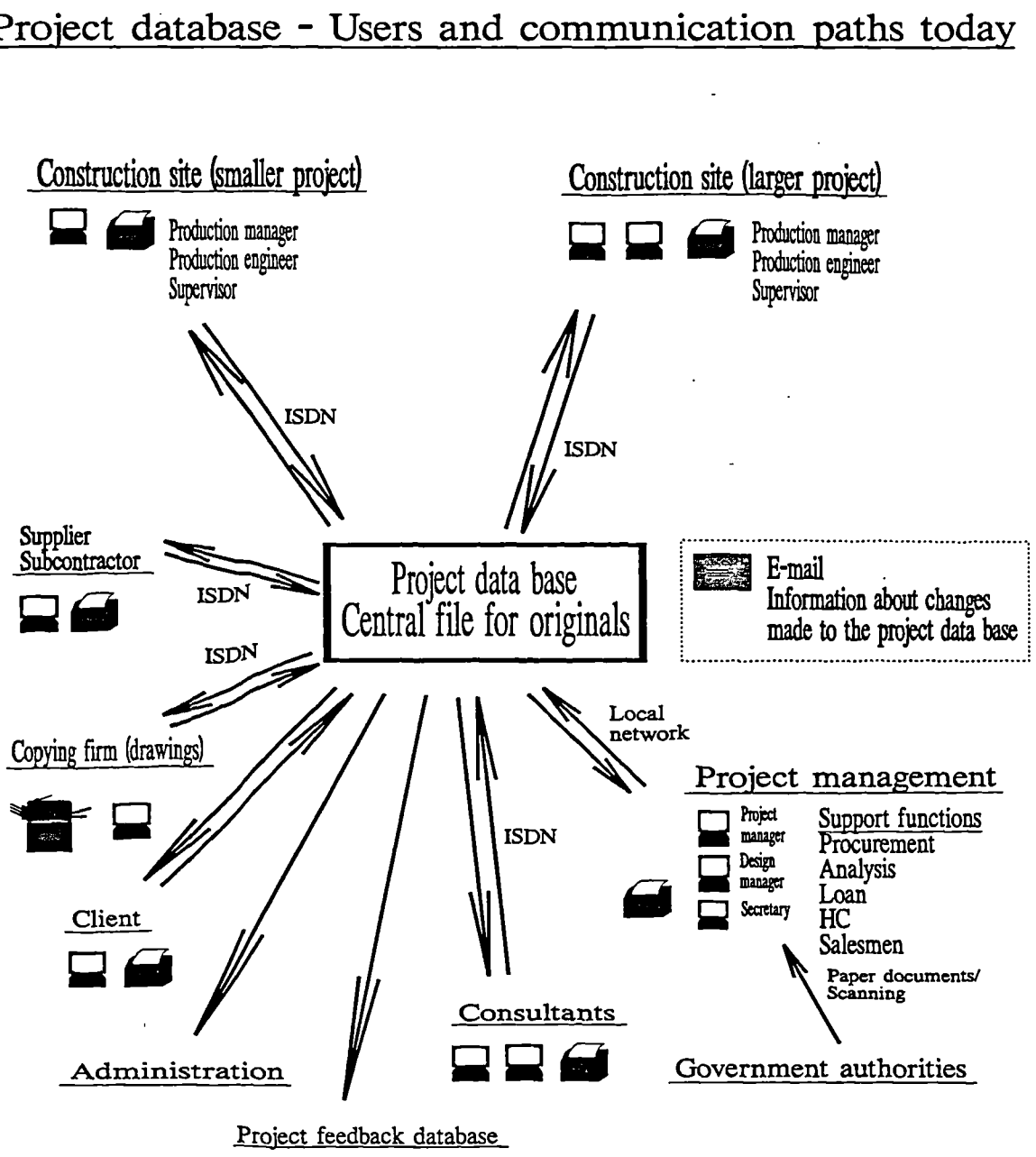


Figure 7.3: JMByggs' Document Management Infrastructure, Svenson and Halmarsson, 1997

The overall analysis of, at the time, document management practices in JMBygg using the Eureka!Filebase EDM system revealed the following limitations inherent to their current system and work methods:

- All the actors must use the same document handling software, namely Eureka!Filebase, in order to access the shared project database.
- All designers must use the same CAD software.
- Document security is no longer as efficient as it used to be for paper-based documents. Any breach in the system can give intruders potential access to the shared project document database.
- A minimum IT expertise is required in order to be able to use the EDM system and search for information.
- There is no support for connection and communication with internal and external databases and information systems (including financial, and property management systems).
- The training, and IT support infrastructure, in place within JMBygg proved to be insufficient. This often results in a rejection of the IT systems employed by the end-users.
- The documents present quite a lot of redundancy. The number of documents needs to be drastically reduced.

7.7.2 Document management practices in Kvaerner

Kvaerner use a document controller to set up an electronic hub for all parties to manipulate, pass and distribute documentation. The document hub provides a collection of services. For instance, it maintains some form of drawing control that keeps track of drawing information, complemented with various functions, including approval, receipt acknowledgement, and document distribution. The hub also manages correspondence (which handles incoming and outgoing mail) and an information control service (which handles information requests from the system), as indicated in Figure 7.4.

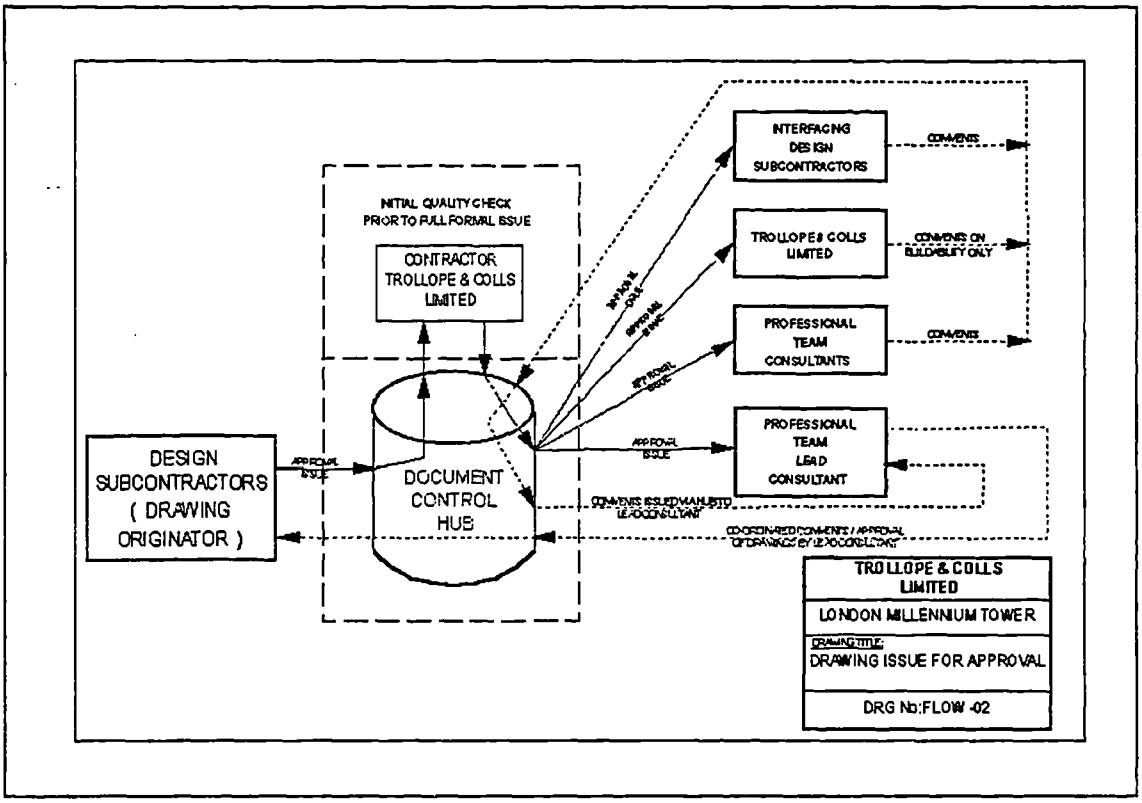


Figure 7.4: An example of document flows in the Kvaerner system, Bew and Blundell, 1997

The functionality provided by the Kvaerner document controller include:

- Receipt and registration of all drawings and written documents.
- Preparation and administration of distribution matrix.
- Retrieval of project documents from, and distribution to, various sources.
- Maintenance record of document status and document issues.
- On-line viewing and redlining for comments and annotations.
- Exception reporting of documents and information not performing to program.
- Scanning and storage of paper prints from all sources.
- Scanning and recording of documents to database and production of contract documentation and correspondence.
- Printing and distribution of all documents.
- Reporting on issues, transmittal acknowledgements and receipts.
- On screen overlay and comparison facility for documents stored within the system.

- Document archiving (file storage on permanent on line media, conforming to relevant BS standard).
- Site-based printing and management facility.
- Off-site back up, support and recovery facility.
- Dedicated document controller and input clerk's.
- Watermarking of uncontrolled documents.
- Ad-hoc report writer.

The main limitation of the Kvaerner system stemmed from its monolithic nature. The proprietary application went through different extensions, undertaken by different teams. This resulted in an increasing complexity, and a lack of flexibility. The maintenance process became cumbersome. All this revealed to be an important barrier to the integration of their system with existing and upcoming component-based software. In addition, all the parties involved on projects had to use the same front end in order to share and exchange documents.

7.7.3 Document management practices in DERBI

The SGT system used by DERBI provides a varied basic functionality for storing, archiving and exchanging various documents, including drawings and written documents, in a structured manner (Figure 7.5). This EDM system also offers a number of advanced services, including a function to co-ordinate the approval process of documents; a change request management service; an advanced construction specific financial tool; and a subsystem (GPP) that is dedicated to the production and management of drawings in a multi-actor environment. GPP uses the concept of layers as a basis for structuring CAD document-based information. Each actor has specific rights over the different set of layers that constitute a drawing. Each layer describes a specific building element (beam, wall, door, etc.). It is worth noting that similar work was being undertaken within ISO, namely: the layering standard proposal (ISO TC10/SC8/WG13). The purpose of the ISO CAD layering standard is to establish an agreed common basis for organising construction data in CAD systems.

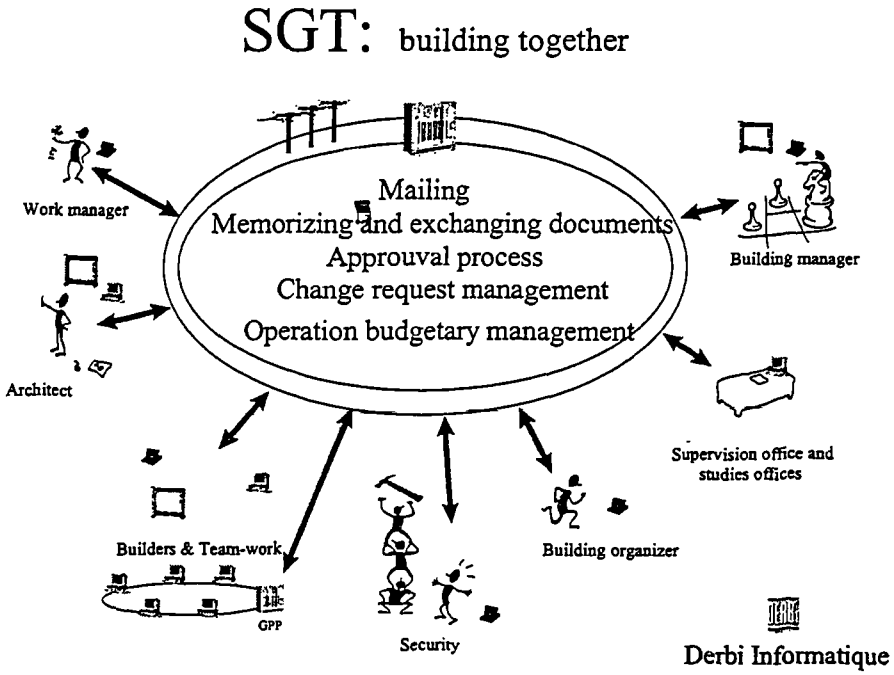


Figure 7.5: An overview of the functionality of the SGT tool, Raffalli and Daussy, 1997

The SGT system was used successfully on several projects in France. It has become one of the important assets of OTH (the main holding of DERBI) to gain more market places, and maintain their competitiveness within and outside France. DERBI have, however, acknowledged some limitations of their current system, in particular, its inability to control the internal semantics of documents. The latter was required in order to support various discipline-orientated queries from end-users, aiming at the search and retrieval of specific project information stored and buried within documents. In addition, DERBI had the early vision of making SGT operational through the Internet. The CONDOR project, as explained later in this PhD document, gave them a unique opportunity in that respect.

7.7.4 Summary of document management practices within the CONDOR end-users

The overall analysis of the document management processes of the CONDOR end-users revealed the following limitations, inherent to their current system and work methods (Rezgui, 1998):

- Every partner must use the same EDM system on a project in order to be able to access and share documents.
- The document's semantics and internal structuring is not controlled by the EDM system. Documents are handled as black boxes.
- The EDM systems used on projects do not support document cross-referencing or semantic linking.
- Document security was always an issue. It is not as easy to implement as for printed documents. EDM systems required improved user authentication and document protection.
- The EDM system is not integrated with proprietary and commercial applications used within the company (e.g. CAD applications and word processors).
- Most end-users in the construction industry are not computer-literate. EDM systems lacking user-friendliness, or used in a maladapted environment (e.g. network communication problems) discourage the user from using the EDM system.

The limitations described above are used to identify and prioritize critical candidate processes for redesign.

In conclusion, after having achieved an appropriate level of understanding of existing processes, a company undertaking BPR must then design the way in which those processes will work in the future. This leads to the third stage of the CONDOR generic BPR model, which aims at the identification of processes for re-engineering.

7.8 Stage 3: Identify process for redesign

The analysis of the business processes and document management practices of the construction end-users involved in the CONDOR project was a very important

stage for the understanding of the end-users business processes, and the specification of the requirements of the CONDOR system. The three end-users involved in CONDOR (Kvaerner construction, JMBygg, and DERBI) were asked, in accordance with the project work plan, to conduct the above analysis within their own company. A brief summary of the results is given in section 7.7, describing the second stage of the CONDOR BPR approach aiming at the understanding of the end-users current document management practices.

The business processes and the document management practices of the three end-users involved in the project have been analyzed (Rezgui and Karstila, 1997). This analysis was then generalized to the whole industry. The latter made use of the Infomate model (Bjork, 1997). The analysis revealed that present document management practices rely to a large extent on manual methods, although the production of documents is mainly done using computers.

It is worth mentioning that the first problem the research team had to face was the choice of a common methodology for process analysis. The research team tried to impose the IDEF0 methodology. However, apart from one partner (Kvaerner Construction) the project end-users felt that IDEF0 was too complicated and difficult to use, and therefore came up with either their own formalism (DERBI), or made use of a flow-chart diagram representation (JMBygg) to describe their processes. The challenge was then to synthesize and abstract the end-users' process activities, as described below, in a way that would facilitate the identification of candidate processes for redesign. The latter were redesigned according to the companies' objectives based on the proposed generic description of the construction and document management process suggested by CONDOR.

Therefore, a hybrid approach making use of the IDEF0 methodology and the Use Case approach, UML (1998), has been used to capture the requirements of the CONDOR system (Rezgui and Karstila, 1997).

7.8.1 Proposed processes for redesign

A detailed description of the CONDOR *generic building and document management activity model* can be found in (Rezgui and Karstila, 1997). The model was developed as a result of the abstraction of the specific information management practices of the project end-users, in accordance with the approach proposed within CONDOR. The main activities of interest to the CONDOR system are described through the "Do building document management" activity (figure 7.6). This activity is made up the following sub-activities:

- *Check, classify and define linking for documents:* this activity represents the authoring process of a document. It is supported by a document processor (e.g. CAD package for drawings, or word processor for written documents). The document being authored might not be visible, at this stage, by the EDM system.
- *Register, import and link document:* this activity represents the registration process of a document. Once registered, the document becomes accessible to authorized users.
- *Search document:* this activity describes the activity of searching for specific documents managed by the EDM system.
- *Retrieve reference, relationship data and document:* this activity describes the process of downloading a document using the EDM system. The user passes the identification (ID) of the document he/she wants to retrieve. The registry requests this document from the information provider that holds the document. The registry passes back the requested document to the person who originated the request.
- *Administer and manage document archive:* this activity represents, on the one hand, the pure administrative activities of the EDM System, and, on the other, the management services that the document management system provides for the users. The administrative activities include defining the classification templates and the documentation structures, performing backups from the document archive, producing statistics from the system in use. The document management services may include the following activities: automatic notification of users for new imported documents in the

system, automatic distribution of imported documents (according to document reference / distribution information), and copying, moving, deleting of documents in the system.

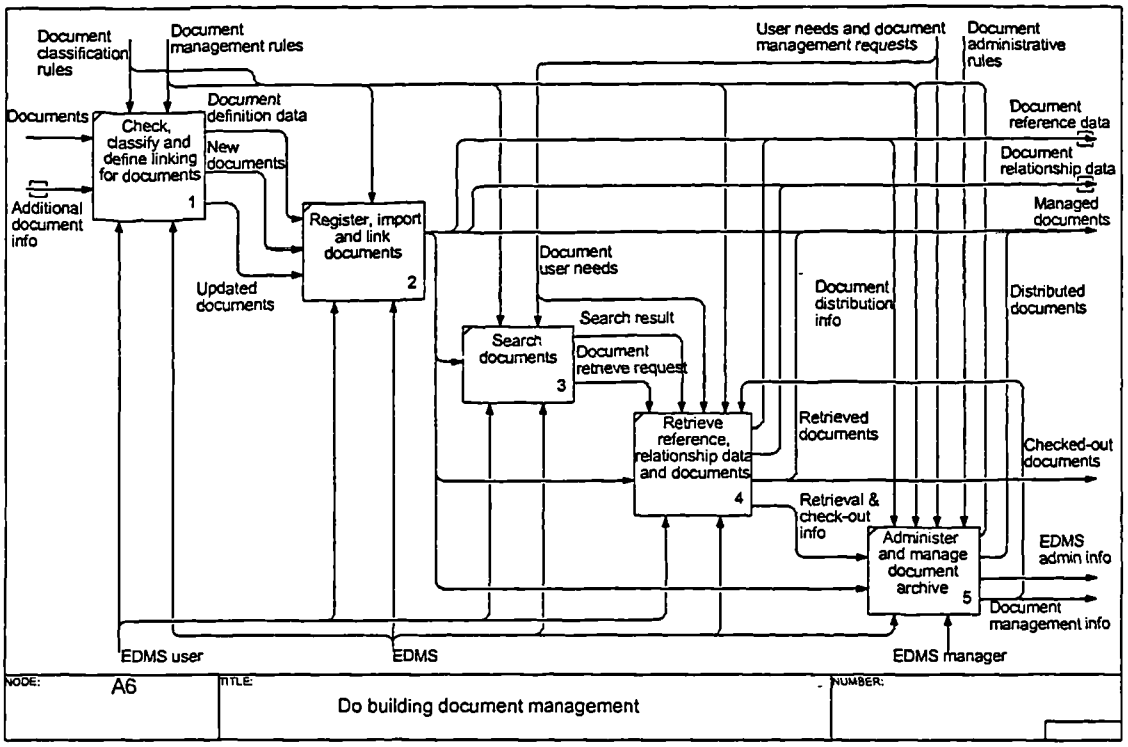


Figure 7.6: Design and do document management activity, Rezgui and Karstila, 1997

It is worth mentioning that the analysis of the end-users' business processes presented in stage 2 (section 7.7) revealed that these companies had varying levels of IT support for their document management practices. These processes were conducted in some companies in a very traditional way, while, in others, they were fully support by IT. Therefore, the identified processes involved different levels of redesign depending on the current process state, and IT support within the end-users companies. This is illustrated in the following two examples:

- Document approval process: this is fully supported by the SGT system (developed and used by DERBI). The same process is carried out in a traditional way in Kvaerner and JMBygg ; the use of IT is limited to downloading a document for approval, and uploading the reviewed

document, using an EDM system. In the case of DERBI, the document approval process needed improving in order to enable other CONDOR compliant EDM systems to participate in the approval process. In the case of JMBygg and Kvaerner, the implementation of this functionality required more consistent re-engineering effort.

- Semantic linking between documents and document parts: the implementation of this functionality meant that it was no longer justified to have within the same organization two separate departments, one specializing in CAD applications, and, the other in written specification documents (as was the case in DERBI). A CAD user could, thanks to the proposed redesigned processes, work on the specification of a building part while working on a CAD drawing. In other words, collaborative authoring of documents was made possible, regardless of the nature (textual or graphical) of the document. This proposed process required a more significant re-engineering effort.

For implementation purposes, the processes identified above were then expressed in terms of functions, packaged in the form of a CONDOR Application Programming Interface (API). The CONDOR API was composed of services promoting inter-working between separate EDM systems, and services promoting information cross referencing between these EDM systems. The end-users implemented part of these functions in order to become CONDOR compliant, and, thus, support the proposed re-designed processes.

7.8.2 CONDOR inter-working services

The API functions supporting the inter-working services are described below:

- *Register():* the purpose of the register() API method is to expose a document, or other information element, to the CONDOR system. Once registered, the document can be accessed using any CONDOR compliant EDM system. As far as the users are concerned, they can retrieve the registered document in a

manner that is familiar to them (i.e. as if the document was stored locally on their own document server).

- *Retrieve():* once a document or object has been exposed to the CONDOR system, it is necessary for other EDM systems to be able to use the document. This is enabled by the Retrieve() method. It is worth pointing out that in order for an EDM system to retrieve a document, or object exposed by the CONDOR system, it must know its corresponding CONDOR unique reference.

- *Store():* in some cases it will be necessary for an end-user to be able to store documents or objects on a remote server. In order to do this the CONDOR system needs to be informed of the location of the server where the document is to be stored.

- *Search():* in order for an end user to ascertain which documents or objects are exposed by the CONDOR system some kind of searching mechanism is required. The Search() method provides this searching capability.

- *Unregister(): a* previously exposed document or object can be removed from the CONDOR system by invoking the Unregister() method.

- Retrieve_meta(): this method allows the user to retrieve the Meta data (e.g. author, date of publication, etc.) associated with a document. This makes it possible to perform statistical analysis on the Meta data without having to retrieve the complete document.

- *Store_meta():* the Store_meta() method allows a user to store the Meta information about a document on a remote server.

7.8.3 CONDOR semantic linking services

It is expected that the implementation of the following functionality is sufficient for most purposes to implement the semantic linking services:

- Add a reference to a document part.
- Link a document to a referenced part of another document.
- Retrieve a referenced part of a document.
- List the referenced parts in a document.

In the following, it is assumed that document parts are themselves documents and that the semantic linking methods will somehow be invoked on the documents themselves rather than through the EDM systems. The methods composing the CONDOR semantic linking services are described below:

- *Add_reference_to_documentprt():* this method is used to add a reference to an existing document part.

- *Add_cross_reference():* this method is used to add a cross reference to an existing document/part into a document which is being authored.

- *Retrieve_documentprt_with_reference():* this method is used to retrieve a document part for which the user has a reference; it is used so that the user can follow cross-references in documents and view related information.

- *List_documentprt_references():* this method lists the references for document parts contained in a document.

7.9 Stage 4: Identify change levers

Change lever analysis relies on both knowledge and creative thinking about how the potential of IT and innovative organisational and human resource approaches might be applied to the re-engineered state of processes (Davenport, 1993). IT is commonly utilised within companies not only to provide effective support to business processes, but also in BPR initiatives in order to redesign processes which limit the competitiveness, effectiveness and efficiency of the organisation. It is argued that within organisations greater attention is generally paid to the design and implementation of technology rather than on human and

organisational factors (Symon, 1992). Oram and Wellins (1995) discovered that most interviewed companies had only achieved around 50-60 per cent of the potential use of IT because they ignored the human factor while designing and implementing new technology. The major factors they identified as determinant for successful IT implementation included quality of staff, and, training and co-operation between users and technical staff.

The selection, design and implementation of a new information technology system inevitably involves many technical issues but it must also meet user and organisational requirements (Eason, 1992). These requirements are classified under the four following areas:

- *Functionality:* the technical specification must cover the functions the system will have to be able to perform in order that it can support the required range of organisational tasks.
- *Usability:* the system has to offer its functionality in such a way that the expected users will be able to master and exploit it without undue strain on their capacities and skills.
- *User acceptability:* the system must offer its services in a way which its users will perceive as not threatening aspects of their work.
- *Organisational Acceptability:* the new system must not only serve immediate task needs but also serve as a vehicle to promote wider organisational goals.

7.10 Stage 5: Implement the new processes

The third stage of the CONDOR BPR approach was concerned with the identification of candidate processes for redesign. The present fifth stage aims at implementing these identified processes (Vakola et al., 1998). Implementation is a critical phase because, often, the system is being partially implemented or, even if fully implemented, is only partially used. In order to avoid these difficulties, the implementation process had to be carefully planned. This stage describes the implementation of a subset of the CONDOR identified processes that support the inter-working services. This was achieved through a demonstrator system. The latter made use of the following EDM systems:

- NOVA: it is a general purpose, Web based, EDM system developed by the Cap Gemini Group.
- SGT: it is a server of documents developed and used by DERBI. It is a conventional client-server application, running on both Unix and NT platforms.
- Eureka!Filebase: it is a documents server developed by Carasoft, and used by JM Byggnads AB.

Each EDM system has been extended in order to implement an appropriate subset of the CONDOR functionality identified within stage 3. It was left up to Cap Gemini, DERBI, and Carasoft to decide on how this added functionality would be implemented within their EDM system. In a previous version of the demonstrator (Prototype V1), a set of documents (stored locally by the SGT, NOVA and EUREKA servers) were made accessible, transparently, via a CONDOR dedicated registry physically located in Salford (UK). This registry was written in Java, and made use of ObjectStore (a commercial object-oriented database) to store documents' meta-data. All interactions between the EDM servers and the registry were handled via TCP/IP and socket-based communications.

However, the latter required the development of a specific protocol to support this type of communication. The present demonstrator makes use the of the Corba 2.0 standard (OMG, 1996). This has provided many advantages, including freeing the programmers from several difficult and error prone low-level programming tasks.

The resulting architecture is shown in Figure 7.7. In the centre, a Corba Name Server is used to store the Corba references of all the CONDOR distributed objects (including documents). When an EDM system needs to connect to other EDM systems (for instance to get the list of all documents located on these remote servers), it first connects to the Name Server in order to retrieve the Corba references of these remote EDM systems. It then connects in sequence to each identified EDM system, using a Corba-based protocol.

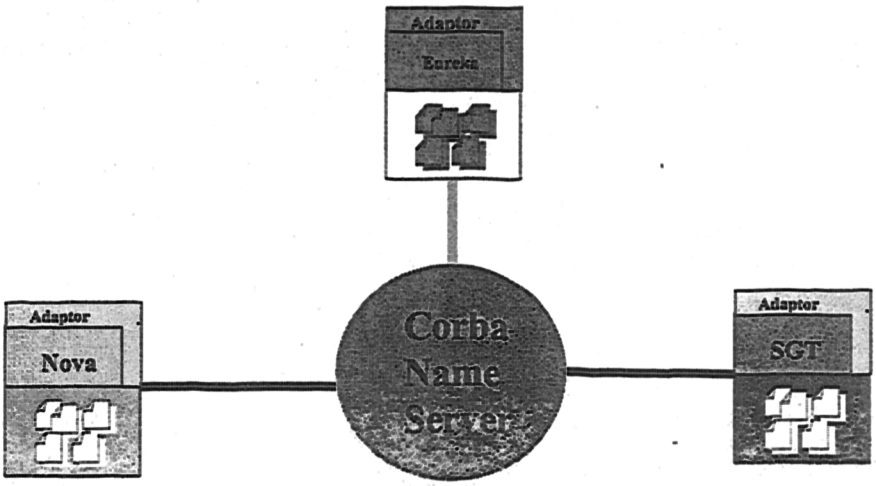


Figure 7.7: Architecture of the Integrated Prototype, Magadur et al., 1998

In order to illustrate how the CONDOR system works, let us examine in detail how a *Search()* command (described in section 7.8.2) is processed by the Nova server. First, the Nova server accesses the IOR (Interface Object Repository) file to retrieve the Corba reference of the Name Server. It then accesses the Name Server to declare itself as a connected server (Figure 7.8). As a result of this declaration, the Name Server keeps track of the binding between the 'logical name' of the EDM system extension (for instance 'Nova') and its Corba reference. This binding will be available to any CONDOR compliant EDM system which may connect to the Name Server to invoke a service that involves the other registered document servers.

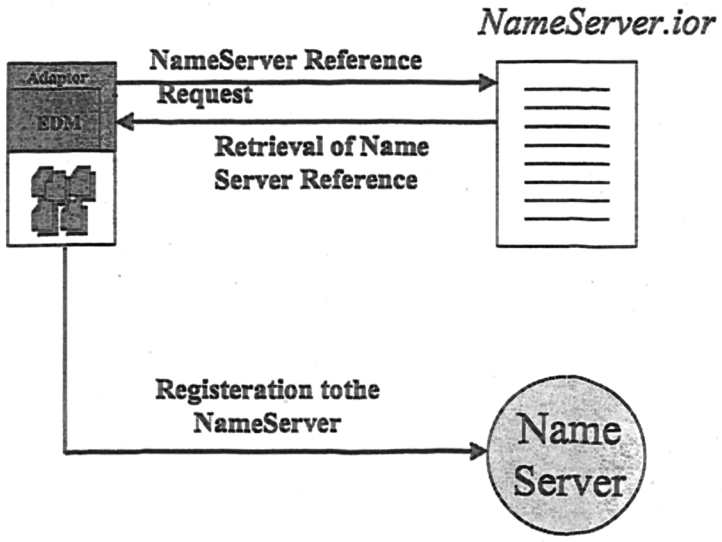


Figure 7.8: The process of registering EDM systems with CONDOR, Magadur et al, 1998

Once the list of bindings has been retrieved, the extended Nova server goes through a loop, to connect in sequence to all registered servers (except itself), as shown in figure 7.9. The Search command is then sent, using a Corba-based protocol, to the available servers, namely SGT and Eureka. The list of local documents exposed to the CONDOR system by SGT and Eureka is sent back to Nova. Finally, the Nova system displays the concatenated list of retrieved document references (available on SGT and Eureka) to the user who originated the request.

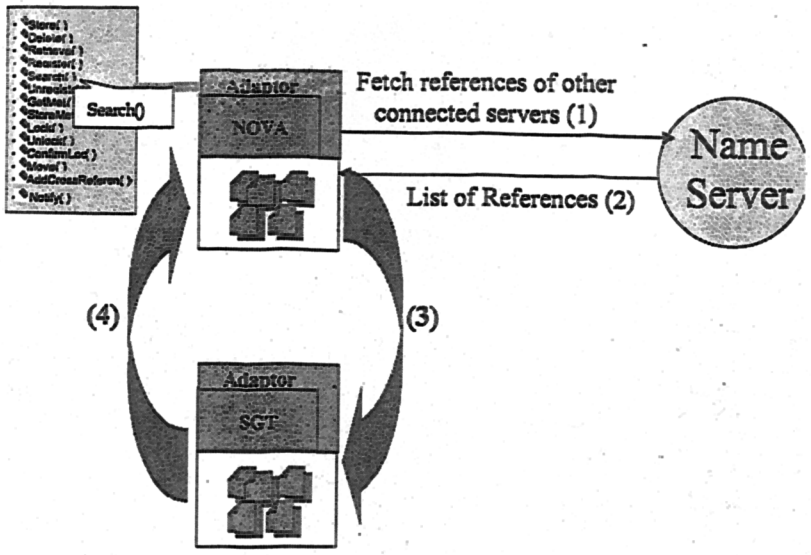


Figure 7.9: An Illustration of the Process of Searching for Documents, Magadur et al, 1998

7.11 Stage 6: Make the new process operational

The sixth CONDOR BPR stage aims at making the re-designed processes operational. A set of field trials have been set up in order to test and validate the extended EDM systems supporting the re-designed processes. Through this procedure, the participating companies had the opportunity to observe and simulate ways in which the re-designed processes function and operate.

Two field trials have been carried out based on two detailed case studies: one proposed and managed by JMBygg, and the other by Kvaerner. In addition to these field trials, a demonstrator has been built by DERBI and CAP GEMINI which made use of a real case study based on the Guimet Museum project. It is worth mentioning that while the demonstrator constituted a unique test bed for simulating and

evaluating the technical aspects of the CONDOR approach, the field trials were restricted, for some of the re-designed functionality, by their overall context (including real site technical and business aspects). For practical reasons, simulated business scenarios applied to real construction projects were used in performing of the field trials. This allowed a more flexible use of project documents, while preventing any interference with the real business processes of the CONDOR end-users on the selected projects.

Professional end-users were involved in the trials. In the UK, due to the nature of the trials, it was felt that employees with a good knowledge of both the EDM system in use and the business as a whole were required, and that the trial should be suitably located to ensure that full technical facilities were readily available. Two quantity surveyors with extensive construction knowledge were involved at Kvaerner Construction Groups Headquarters at Maple Cross.

For trials in Sweden, a larger team was involved, including two project managers, one design manager, two drawing managers, one supervisor, two IT managers, and three external people (a programmer from Carasoft, and 2 research students from KTH).

The trials in Sweden and the UK were performed during the two last months of 1998. The UK field trial was aimed at testing the proposed inter-working services described in section 7.8.2, including Search(), List(), Retrieve_meta(), Retrieve(), and Register(). The Swedish field trial addressed, in addition to the inter-working services, some more advanced functionality, including the handling of the instances of a product model using the Industry Foundation Classes developed by the International Alliance for Interoperability. The users were continually reminded to concentrate on the functionality of the extended EDM systems, as opposed to concentrating on the individual screen layout and contents. A detailed description of the UK and Swedish field trials can be found in (Bourdeau et al., 1999).

As mentioned above, a demonstrator has also been produced to operate the re-designed processes. The used scenario, described below, is based on a real project "Guimet Museum" on which DERBI is currently involved. The project is located in

Paris. The simulated scenario, based on real project documents, involved the following actors:

- The project manager from DERBI (Paris), who interacts with the project document base using the SGT system.
- The architect from JMBygg (Stockholm), who interacts with the project document base using the Eureka system.
- A door supplier based in Paris, who interacts with the project document base using the Nova system.

The scenario starts with the project manager who receives an important request for modification, from the client, on some doors used in the project. The new specifications, regarding the doors in question, are stored in a document (CHAN-022.DOC) managed locally by the SGT system. Figure 7.10 presents the process of registering the document with the CONDOR system. As a result of this registration (made by the project manager), an e-mail message is sent to a set of actors who need to be notified about this request for modification. The actors being notified include the architect (based in Stockholm), and a door supplier (based in Paris).

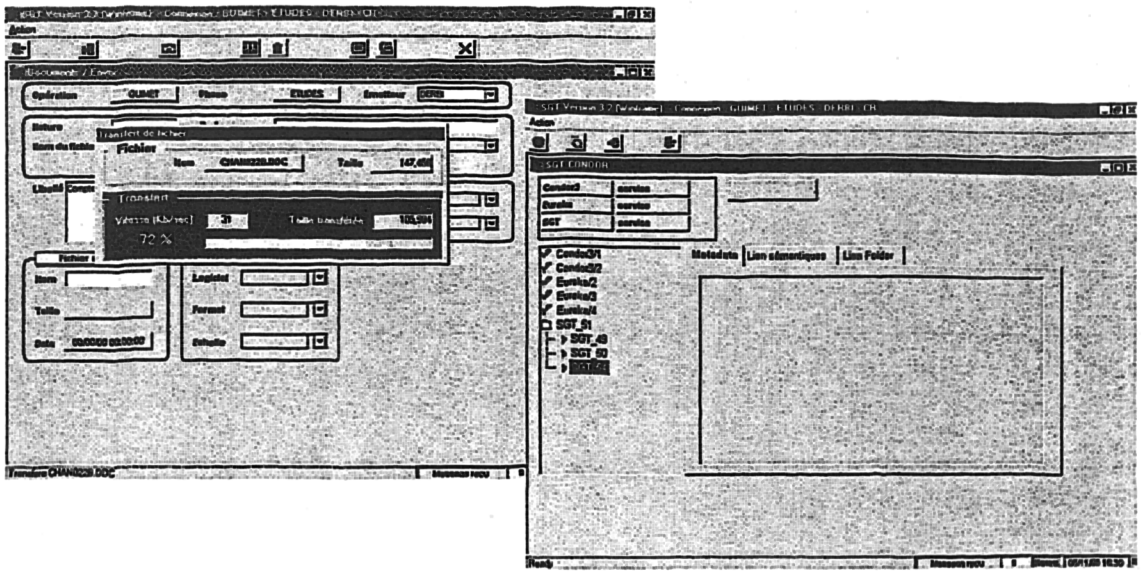


Figure 7.10. The process of registering a document with the CONDOR system using SGT, Bourdeau et al., 1999

Once notified, a technical person representing the company that supplies doors for the Guimet Museum project connects to the CONDOR system using Nova, and then retrieves the CHAN-022.DOC document (Left panel of figure 7.11). Based on this updated technical description of the doors, he selects from the company catalogue a new type of door matching the new specifications. The technical details of the door are described in a document, DOOR_REF_208907.DOC, that is uploaded to the CONDOR system using Nova. The meta information of this new document is displayed on the right panel of Figure 7.11.

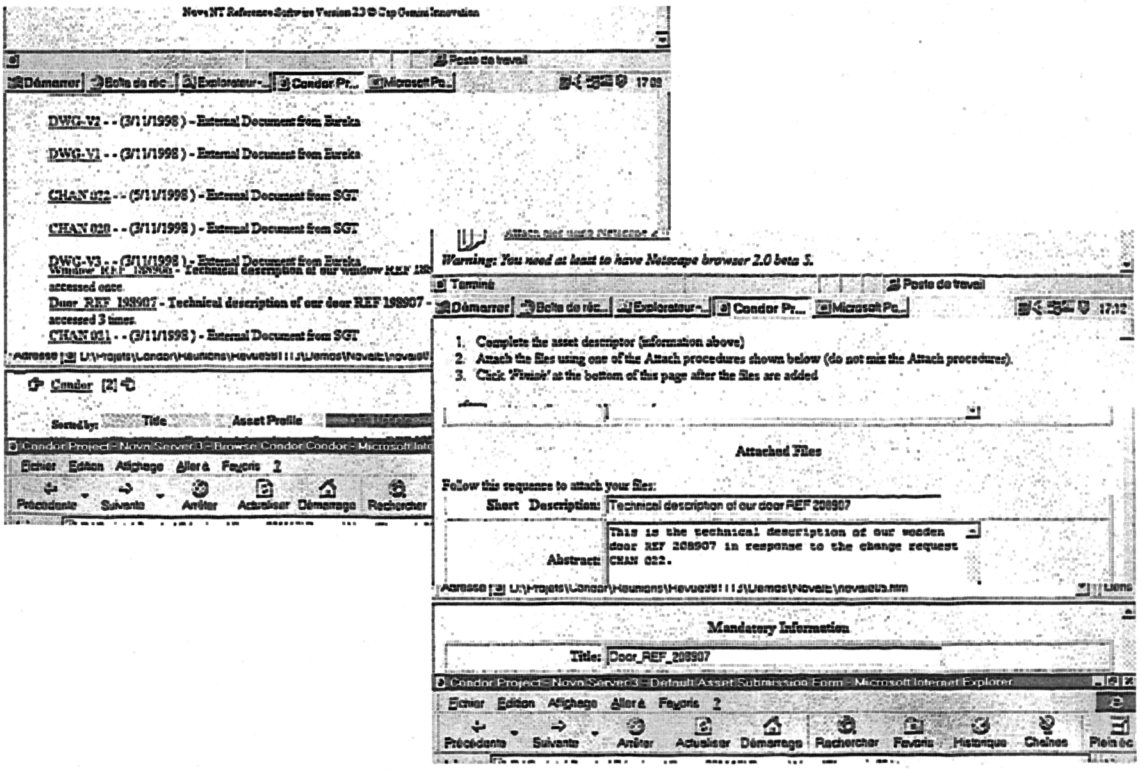


Figure 7.11: Retrieving and then uploading a document to CONDOR using Nova, Bourdeau et al., 1999

As soon as the document DOOR_REF_208907.DOC is uploaded onto the CONDOR system, a commercial person, from the same company that supplies doors, receives an e-mail notification message. Using the same Nova system he retrieves the document. Based on the specifications contained in this document (DOOR_REF_28907.DOC), he makes a commercial offer and uploads the resulting document (CommercialOfferForDoor_REF_28907.DOC) onto the CONDOR system, as illustrated in figure 7.12.

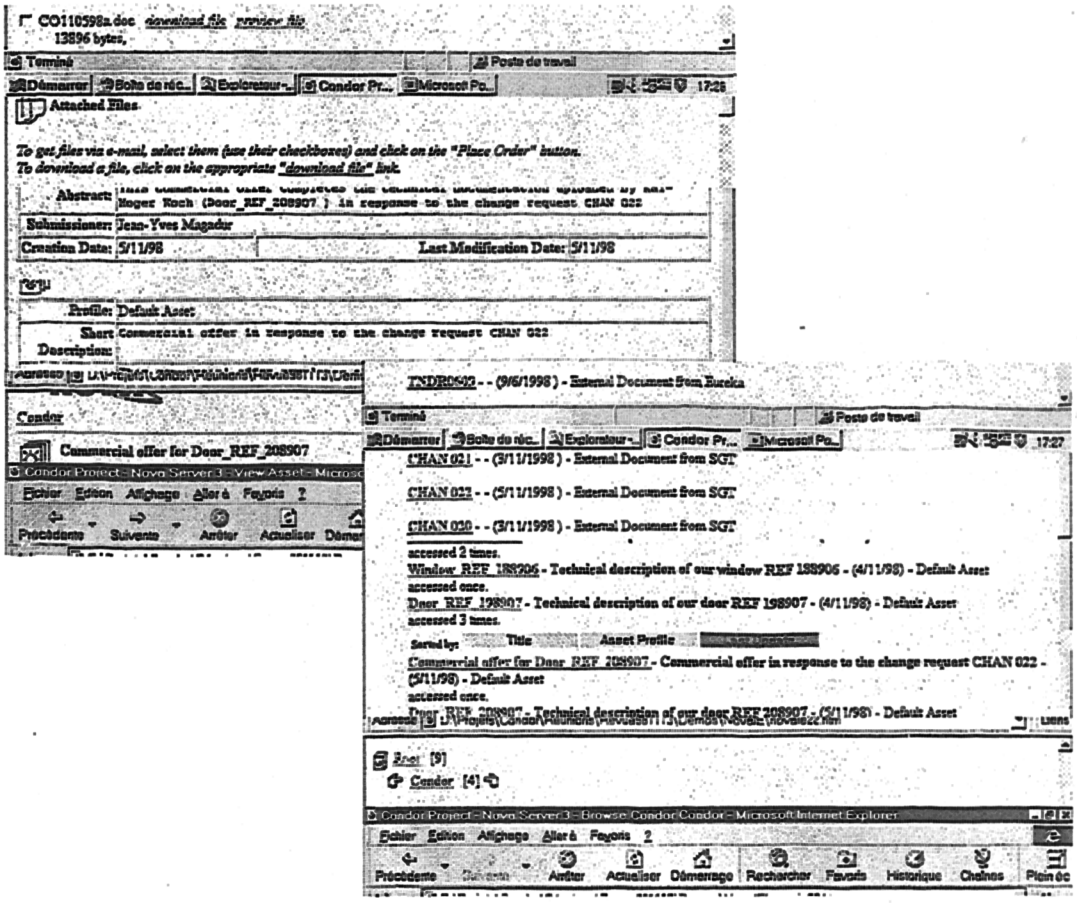


Figure 7.12: Uploading the new commercial offer onto CONDOR using Nova, Bourdeau et al., 1999

Sometime later, the architect, based in Stockholm, retrieves the description of the requested changes (CHAN-022.DOC) along with the latest version of the related AutoCAD drawing (DWG-V3.DWG), using Eureka. He modifies the AutoCAD drawing accordingly, adding a cross-reference to the document describing the request for change (for future reference). This is done thanks to an extension to the AutoCAD application implementing some of the CONDOR API functions, including Add_cross_reference(), as illustrated in figure 7.13. He, then, uploads the new version of the updated drawing (DWG-V4.DWG) onto the CONDOR system.

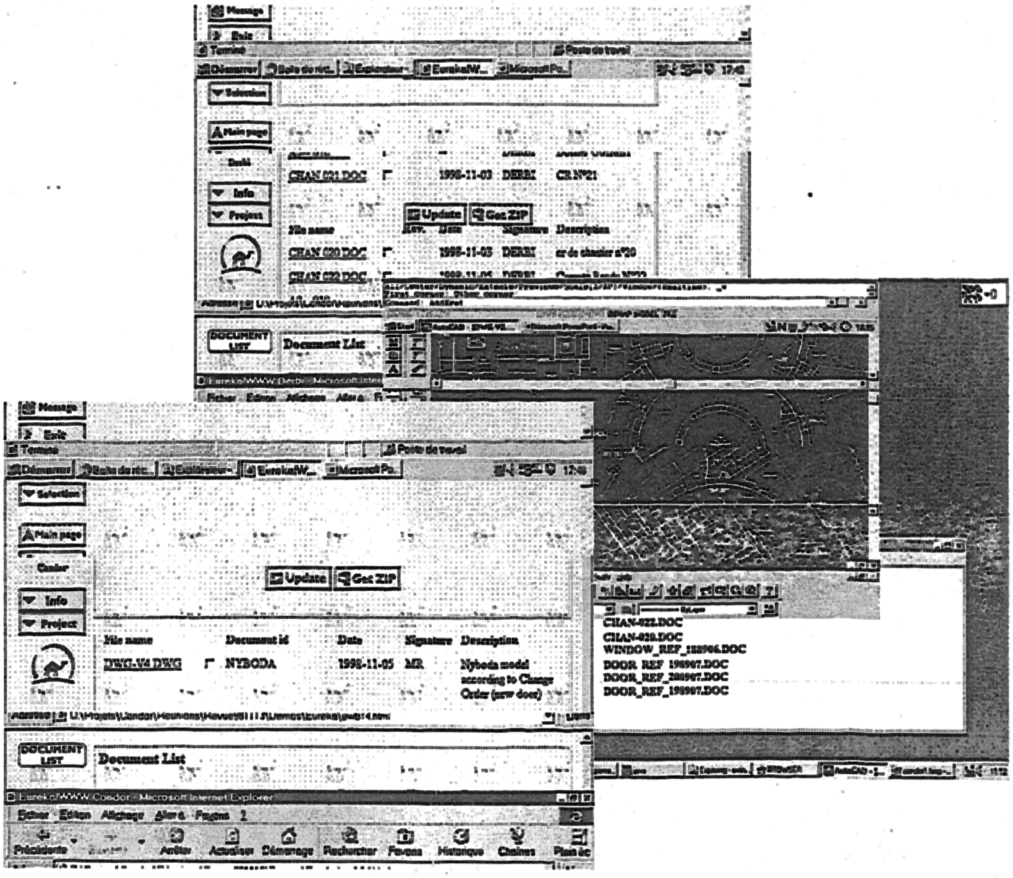


Figure 7.13: Uploading a new drawing file onto CONDOR using Eureka, Bourdeau et al., 1999

7.12 Stage 7: Evaluate the new process

The evaluation stage is very crucial for the whole BPR model. At this stage, we are in a position to attempt an evaluation of the potential achievements and advantages provided by the CONDOR system. The field trials were intended to prove the capability of the CONDOR approach to improve document management efficiency in actual operations in the construction field. During the performance of the field trials and tests on the demonstrator, data was collected for technical, social and economical evaluation. Suitable qualitative and quantitative criteria were determined as part of the case studies development. These included not only evaluation of the usability of the CONDOR system by end-users, but also estimates of potential time saved, and changes to working practices in order to maximize benefits.

Four aspects have been taken into account for the evaluation of the usability of the CONDOR system, including system functionality, system efficiency, user-friendliness, and technical aspects (Bourdeau et al. 1999). These are detailed below:

- *System functionality*: this aims at assessing the level of support of the functional requirements determined during the analysis stage, and verifying that the re-designed processes meet the functional specifications described in stage 3 of the CONDOR BPR approach.
- *Efficiency*: this aims at ensuring that the proposed CONDOR infrastructure addresses, and provides satisfactory solutions, to the previously identified problems (section 7.7.4).
- *User-friendliness*: this addresses human computer interaction issues, and assesses the overall system friendliness, including navigation and access to information and documents, input data devices, and Desk help.
- *Technical aspects*: this aims at analysing and preventing potential system failures (system shutdowns, network communication problems, lack of data, etc.).

The field trials have been performed with the view of assessing the CONDOR system in realistic business conditions. This objective has been achieved, partly from experience gained by professionals through actual building projects (as was the case for JMBygg), partly from simulated scenarios involving selected end-users (as was also the case for JMBygg and Kvaerner). The results presented hereafter demonstrate the level of document management support provided by the CONDOR approach in actual operations in the construction field, based on the JMBygg and Kvaerner field trials.

7.12.1 Evaluation of the JMBygg field trial

JMBygg had a successful response rate from the questionnaires sent to the users involved in the field trials regarding the advantages and disadvantages related to Eureka!WWW (the Internet version of Eureka) used for the performing of the field trials. A summary of these responses is given below (Table 7.1):

Advantages	Disadvantages
➢ Improved user friendliness.	➢ Internet network communications can be sometimes very slow.
➢ Improved document control.	➢ The CONDOR system requires fairly high hardware specification.
➢ Improved accessibility to project information.	
➢ Secure document storage.	
➢ Easy access to up-to-date information.	
➢ Very little EDM training is needed.	
➢ Working places can be mobile.	
➢ Information distribution is easy with built in e-mail systems.	
➢ Cost effective.	
➢ Overall more environmental friendly.	

Table 7.1: Users' responses to JMBygg field trials

A number of changes in JMBygg's information management practices and overall business processes have been implemented within the CONDOR project. The impact of these changes on the end-users' daily practices has been carefully analysed. The views expressed by the end-users are summarised below.

- *System functionality*: the end-users were satisfied overall with the performance of the CONDOR system, despite some problems inherent to the nature (prototype form) of the system. The most convincing aspect of the CONDOR system was related to the easy and transparent access to all project information, over the Internet, regardless of its form, format, and location. The added functionality of the CONDOR system was easy to comprehend, even if some end-users would have appreciated more responsiveness, and feedback from the system during operation (e.g. trouble shooting operation).

- *Efficiency*: all end-users agreed that the CONDOR system can potentially improve the building process through a better structuring and exchange of information. The main acknowledged benefits of the system included an improved access to all project documentation, better communication between actors, and improved user-friendliness of the EDM system. The security aspects of the CONDOR system haven't been implemented. The users have expressed a demand to support information privacy by controlling access rights over shared documents, and non-repudiation (so that a user can not deny the receipt of a document). As regards modifications and change management, it was felt important to ensure that changes are notified to all concerned actors in due time. The expected increase in productivity has been estimated between 5% and 15%.

- *User Friendliness*: the end-users have expressed some concerns as regards the user-friendliness of their existing system prior to the start of the CONDOR project. They seemed quite pleased with the improvements on this aspect of their CONDOR compliant EDM system. This was due mainly to the improvement in the area of Graphical User Interfaces, used for the development of the prototype, along with an overall improved transparency of the EDM system as regards the access to remote documentation.

- *Technical Aspects:* this is an area that requires some improvements. Many bugs have been reported, along with some network communication problems over the Internet. These were mainly due to the nature of the system: a working prototype under development.

7.12.2. Evaluation of the Kvaerner field trial

The same evaluation process took place within Kvaerner. The employees were asked to evaluate the new implemented functionality of the CONDOR system. Their views are summarised below.

- *System functionality*: the Kvaerner end-users were satisfied overall with the implemented inter-working functionality of the CONDOR system. They have

acknowledged the process improvement in relation to accessing and retrieving remote up-to-date documents, in a transparent way. It was felt that the added functionality was easy to comprehend overall. This didn't cause any constraint on the end-users information management practices.

- *Efficiency*: the CONDOR system promotes communication between project actors, and better integration of the documentation used on projects. However, the network communication of the CONDOR system was felt to be overall fairly slow, in particular when accessing documents located on distant servers (located in a different country). Document security was also an issue. As with JMBygg, the users have expressed a demand to support information privacy by controlling access rights over shared documents. The expected increase in productivity was estimated to be less than 5%.

- *User-friendliness*: as with JMBygg, the end-users were fairly satisfied overall with the human computer interaction issues related to the use of their CONDOR compliant EDM system. The limitations expressed in this respect on their existing EDM system didn't seem to be an issue for the currently evaluated one.

- *Technical aspects*: Many bugs were reported, along with some network communication problems over the Internet. The end-users were aware that the evaluated EDM system was a working prototype under development.

7.12.3. Summary of the field trials evaluation process

The first results from the above field trials proved satisfactory. The main recommendation resulting from the evaluation work stresses the importance of the reliability of the hardware infrastructure in place (including networking) if the CONDOR system is to be used effectively.

The two field trials were based on the Internet version of Eureka!Filebase, namely Eureka!WWW. This EDM system implements a wide range of CONDOR functionality promoting the sharing and integration of documents. The evaluation of

the inter-working services was not addressed within the field trials. However, these inter-working services have been successfully tested on the demonstrator system, presented in section 7.11.

This demonstrator gave the research team an opportunity to test almost all the technical features of the CONDOR system, which cover both the inter-working and semantic linking functionality. The development of the CONDOR demonstrator was carried out by both Cap Gemini and DERBI.

Compared to the first version of the CONDOR system, the inter-working functionality between the end-users EDM systems was improved thanks to the use of a CORBA-based middleware. No common repository was needed, and network communications over the Internet were simplified. As far as the end-users are concerned, the List(), Get-meta(), and Retrieve() functions were invoked transparently on documents that were stored on both their local and remote server(s). The demonstrator also illustrates the semantic linking functionality between document parts through the AddLink() function, as indicated in the scenario described in section 7.11.

7.13 Stage 8: Ongoing continuous improvement

Business Process Re-engineering is a successive and ongoing process. BPR should be regarded as an improvement strategy that enables companies to make the move from a traditional functional orientation to one that aligns with strategic business processes. Once a company is committed to business process change, innovative use of IT and human resources can be used as its principal enablers.

The process re-engineering work, which took place in CONDOR, has shown that BPR is an 'endless' process. A re-engineered process may reach a satisfactory state of efficiency but the organisation as a whole will never stop competing in a continuously changing environment which leads to the transformation of business strategy and vision, and as a result to the continuous need for improved organisational processes and functions.

The project end-users have realised the limitations of their existing information management practices. They have also realised the potential benefits that they can expect from the adoption of the CONDOR approach. The latter has triggered a great deal of awareness and concern about their current practices. IT support for business processes has become an important topic discussed on a regular basis within the management committees of the CONDOR end-users. As a result, in addition to implementing the CONDOR document management solutions, the end-users are reviewing every single aspect of their daily business processes. They are trying to identify weaknesses, and come up with adequate integrated solutions. This work is now undertaken at a strategic level within the whole company.

The researcher has contacted the participating companies after the completion of the CONDOR project and she has conducted an interview with the technical co-ordinator of the project. The main aim was to explore if the companies still trying to improve their processes after the completion of CONDOR project. The main findings are the following:

- DERBI has produced at the end of the Condor project a Beta-version of an Internet-based version of SGT, namely SGTi. They have recently completed the testing, within the OTH Group, of their new software, and are about to start using it on several projects in which OTH are involved. It is worth mentioning that CAP Gemini has also recently acquired the SGTi software in addition to their NOVA EDM system offer. It seems that SGTi offers a better competitive advantage in that it is faster and easier to deploy within a company, and doesn't require high hardware and software requirements to operate. DERBI is presently satisfied with the overall improvements made to document management practices within OTH, and this is acknowledged across the various subsidiaries of the group. They have started working on two research and development themes funded partly by the group: Workflow support, and Knowledge management. As regards the first theme, DERBI has been successful, as a co-ordinator, in winning a Framework5 IST (Information Society and Technologies) project: OSMOS (IST-1999-19984). The overall aim of the OSMOS project is to enhance the capabilities of construction enterprises, including SMEs, to act and collaborate effectively on projects by setting up and promoting value-added Internet-based

flexible services that support team work in the dynamic networks of the European construction industry. The main objective of DERBI is to integrate SGTi with a set of tools commonly used on projects (e.g. CAD) in order to allow users to participate in collaborative work in a dynamic Construction virtual enterprise while providing distributed information management support. As regards the second theme (knowledge management), DERBI is trying to develop organisational practices that promote effective knowledge dissemination and capitalisation across projects and the various subsidiaries of the OTH Group. DERBI is also in the process of submitting a second IST proposal addressing this important theme. These latest developments suggest that the Condor project was a positive experience for DERBI. This is confirmed by their strong commitment to research and development projects carried out in conjunction with European multi-disciplinary teams and organisations.

- Kvaerner is still using an electronic hub for all parties in order to manipulate, pass and distribute documents. Although they did recognise the importance and the usefulness of the CONDOR system, they have decided to continue using their existing systems and processes as they are. There isn't any more information regarding Kvaerner's progress after the completion of the project due to internal difficulties and politics. As a result, the researcher didn't approach the representatives of Kvaerner.
- JM Bygg had mixed feelings regarding the outcome of the Condor project. While Carasoft (that develops the Eureka EDM system) exploited fully the opportunity offered by Condor, JM Bygg tried to address a wider scope that went beyond the objective of the project. They were at some point trying to integrate their entire software infrastructure as part of the project. They have also experienced some financial problems for the payment of their expenses by the EC that did have a slightly negative impact on their involvement in Condor. Overall, JM Bygg has simplified the handling of their documents by using a web-based EDM system named Eureka!WWW developed by CaraSoft. This system is used in several projects and seems to meet JM's functional requirements and match competing products regarding price and quality. Eureka!WWW provides fast access for project partners including suppliers, easy handling for users, full-text search and high functionality. JM Bygg is trying now to move to a more global, intelligent, process-controlled information

system. In these systems the refinement of information by using intelligent IT tools is very critical. JM Bygg is hoping, through their involvement in the OSMOS project, to achieve this objective. They did overall acknowledge the benefits of research and development projects, such as Condor, which is confirmed by their involvement in the OSMOS project. On the other hand, Carasoft has put in practice the creation of "Dokumentbanken ™" (The Document Bank ™ www.docbank.com). The idea for the Document Bank is to provide the service of written document and drawing management on the internet, together with important accessories for project management, including viewing document and object relations. The Document bank provides a secure Internet connection. Carasoft estimate Dokumentbanken AB to be a major customer in Sweden in 1999 and onward. Furthermore, Carasoft is currently in talks with several important communication companies, for more possible joint ventures, where the most promising so far is the DECT division at Ericsson Business Centre, and the GSM division of Ericsson Radio Systems.

7.14 Conclusions

This chapter has described and analysed the development of the CONDOR BPR methodology and its implementation to the three participating construction companies. The eight stage methodology suggested by CONDOR enabled and supported the re-engineering process. However, the description and the analysis of the methodology are inadequate. The companies were asked not only to apply the CONDOR BPR methodology but also to critically evaluate it. This is the rational behind chapter 8 which will be presented in the following section

Chapter 8

Evaluation of implementation strategies

This chapter discusses the role of evaluation in business process re-engineering and presents the evaluation results of the business process re-engineering implementation in the three case studies of the current thesis. At the end of the chapter, a summary of the evaluation results is presented.

8.1 Introduction

As stated in chapter 7 (practical applications of the CONDOR BPR methodology), one of the most critical weaknesses of existing BPR methodologies and models regards the lack of evaluation. Although academics and practitioners have extensively produced and used BPR methodologies, there is not enough evidence in the literature about the evaluation of existing methodologies in terms of potential profits, coming from the efficient use of the suggested models, and possible changes in human and organisational requirements such as culture, structure, communication process, and resistance to change.

This chapter aims at presenting an evaluation of the CONDOR business process re-engineering methodology. This evaluation has been conducted in the light of the deployment of the suggested model within the three CONDOR end-users. The potential benefits are highlighted along with identified potential weaknesses of the proposed methodology. It is worth mentioning that this evaluation of implementation strategies is crucial since the rationale of the methodology is based on the concept of ongoing improvement as part of the re-engineering process. In addition, the evaluation work will be used in order to address the research questions presented in chapter 3 (research questions).

8.2 The role and importance of evaluation in business process re-engineering

Evaluation has emerged over the past few years as a valuable management tool. It is based on the systematic collection of information about business processes, projects, initiatives, products, and personnel and programs (Quinn Patton, 1990). UNICEF (1991) defines evaluation as *"a process which attempts to determine, as systematically and objectively as possible, the relevance, effectiveness, efficiency, sustainability and impact of activities in the light of specific objectives"*. Evaluation is undertaken to inform decisions, clarify options, reduce uncertainties, and provide information about programmes, policies, processes within contextual boundaries of time, place, values and politics (Quinn Patton, 1990). This information can be used by managers and decision-makers to:

- reduce uncertainties;
- improve effectiveness;
- identify reasons for success or failure.

Evaluation gives a reliable, independent assessment of the results of continuing activities and information on which decisions can be based. Managers need to understand the effects of their activities to look for alternative approaches and test their results. Evaluation can provide objective information, supply credible answers, and identify the reasons for success or failure (Caulley, 1993).

Scriven (1967) has introduced two different types of evaluation. He calls the first one "formative evaluation" which is based on the collection of information that can be used primarily for programme development and improvement, and the second one "summative evaluation" whose primary purpose is to make an overall judgement about the effectiveness of a given programme. According to Sherwood-Smith (1994), formative evaluation in BPR aims at impacting in an incremental way on decision making throughout the re-engineering process, whereas summative evaluation is used in order to validate or reject the final outcomes.

Academics and practitioners have realised the need for the evaluation function within the organisation, and very recently have been focusing on the use of evaluation as a strategic tool for knowledge and information acquisition and construction with the aim of facilitating decision making and organisational learning (Segone, 1998). Evaluation as a management tool is a critical success factor in business process re-engineering, and there is a need for evaluation in every stage of the re-engineering process. There are several reasons that justify the necessity for evaluation in organisations and especially in change initiatives. Firstly, evaluation aims at problem solving and decision making (Scriven, 1980). According to Wholey (1994), evaluation is defined as a problem-solving process or as a process that provides information for decision making. Sherwood-Smith (1994) argues that evaluation supports informed decision making which is necessary in every stage of the business process re-engineering initiative. Also, by gathering information and generating knowledge, those involved or affected by the BPR process have the opportunity to understand all the issues involved in the process and therefore to communicate more effectively.

Secondly, another scope of evaluation is knowledge construction and capacity building (Segone, 1998). As it has been mentioned in chapter 3 (Research questions), the use of 'lessons learned' is a critical success factor in the construction industry. Evaluation facilitates the process of knowledge transfer to similar situations. According to Segone (1998), lessons are transformed into knowledge when they are analysed, systematised, disseminated and internalised within an organisation through evaluative processes. Therefore, evaluation can be used in business process re-engineering effort as a tool in order to gather information, systematise the lessons learned and then disseminate this information in order to improve similar projects, processes, or change initiatives in the future.

Finally, the literature review has shown that change initiatives such as business process re-engineering may cause resistance to change (Burnes, 1992). Resistance to change is a critical issue in all change initiatives because it may lead to a lack of co-operation and communication among those involved and affected by the change process. Evaluation, which is based on gathering information, analysing it and communicating it effectively, facilitates the process of behavioural and

attitudinal change among organisation or project members. As a result, evaluation enables continuous adaptation of the organisation to the internal and external changes (Segone, 1998). This ability is closely related with organisational learning that promotes organisational growth and improvement. These factors are particularly important for the construction industry (Egan, 1998).

8.3 Evaluation within CONDOR

Although evaluation can facilitate the change process, and is a major asset in the business process re-engineering effort, there are many reasons that can potentially obstruct this process. Quinn Patton (1998) identified some of the most important reasons:

- Fear of being blamed; fear that the evaluation will be used punitively.
- Fear of being shamed; fear that the weaknesses will be highlighted and failures made visible.
- Fear of uncertainty; not being sure what will be found out, how results will be used.
- Fear of politics: scepticism about political considerations that can affect all the other issues.
- Fear that the evaluation will be unfair: inappropriate criteria, and wrong objectives.

The above factors have a major impact on the organisation as a whole. As a result, the organisational change (which is a very complex process that depends on many organisational characteristics such as culture, communication, and structure) may be affected negatively and lead to failure.

The CONDOR project has incorporated in its methodology an element of evaluation in an attempt to facilitate the change process and the deployment of the proposed solutions within the end-users' organisations. Evaluation is viewed not as a discrete point in the life of the project/organisation but as an ongoing and contributing factor to the extremely complicated process of organisational change

through the setting of new priorities, objectives and strategies after reconsidering the existing ones.

Therefore, having realised the cultural and organisational differences (partners from different European countries) between the parties involved in the CONDOR project, an appropriate methodology was developed in order to accommodate the potential project complexity, and to enable the end-users to adapt themselves in a continuously changing environment. The suggested approach was incremental and iterative as indicated in Figure 8.1.

The CONDOR components (including requirement analysis, architecture, models, and prototypes) were developed as the result of a series of iterations. By adopting this approach, a certain degree of uncertainty in the specification of the end-users requirements was tolerated and supported. In fact, change was anticipated at any stage of the CONDOR system lifecycle. Potential risks were identified and prioritised early in the lifecycle, and were at the core of each iteration leading to the final solution.

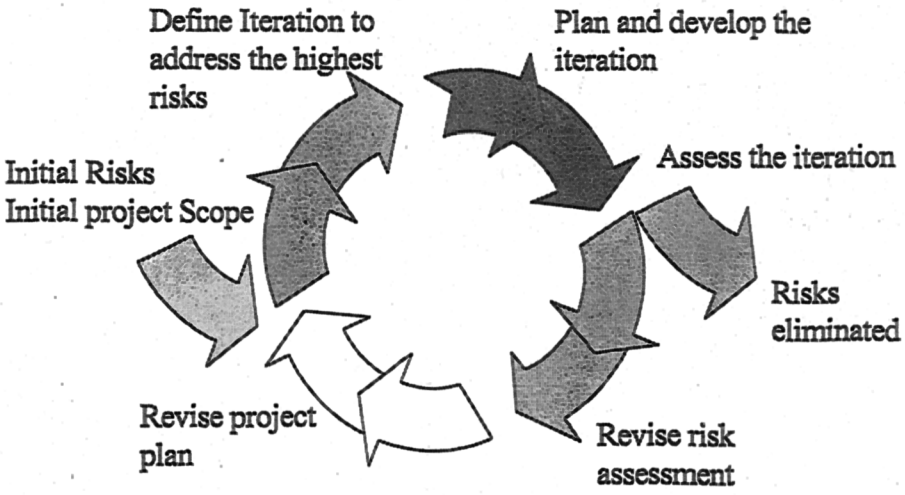


Figure 8.1: Iterative and Incremental Development Approach Rezgui, 1998

Therefore, the following three iterations have been conducted:

- Iteration 1 is primarily concerned with the specification and implementation of the inter-working services between dissimilar EDM systems.
- Iteration 2 is concerned with the validation of the CONDOR inter-working services described in chapter 7 (practical applications of the CONDOR BPR methodology), and the implementation of the CONDOR semantic linking services.
- The third and final iteration is concerned with the validation of the overall approach.

The evaluation of the outcomes from each iteration was made mainly through review meetings where the project results and achievements were presented to the project officer (from the European Commission) and the project reviewers. It is worth mentioning that the proposed CONDOR models and API functions have been refined in the light of the implementation and evaluation work. This is due to the following reasons:

- Limitations inherent to the technology on which the end-users EDM systems are based (e.g. native relational versus proposed Object-Oriented stores of data, native Procedural versus Object-Oriented programming language required to support some advanced proposed functionality, etc.).
- Change or evolution of the initial end-users business requirements.
- Cultural differences between the end-users and different perceptions and interpretations of common concepts, including semantic linking.
- The project duration was a determining factor. After a while, the consortium members considered that two years were not enough to implement the entire proposed project functionality, given the scope and complexity of CONDOR. The emphasis was, for some complex functionality, put on producing a proof of concept, while implementing the most essential and feasible functions.

The CONDOR end-users have been familiarised with the concept of evaluation, and its potential benefits, from the inception of the project. They agreed to apply the proposed BPR methodology in a real life scenario, evaluate it, and then

document every single aspect of their findings. The researcher was involved in this process aiming at guiding and monitoring the implementation process of the CONDOR BPR model. The researcher was also in charge of the evaluation of the end-users' implementations by trying to make abstraction of contextual situations, and interpret their findings objectively.

The three participating companies went through and evaluated the re-engineering process based on the eight stages of the CONDOR BPR methodology. By analysing the information given on what happened during the re-engineering process, a description of the decisions made by the three companies and of the problem solving process was produced. These descriptions provided information about the realities of the business re-engineering process in the three case studies. By analysing the responses, information was gathered on the process of problem solving including the evaluation of options.

The following sections describe the evaluation of the implementation strategies, and synthesise the results in order to give answers to the relevant research questions. The evaluation of the suggested BPR methodology was conducted based on certain criteria. The researcher formulated these criteria based on the evaluation standards described by The Joint Committee on Standards for Evaluation (1994) and other evaluation criteria used in similar projects (Betts, 1998). These criteria are as follows:

- *Business Performance Improvement*: The three case studies were asked to evaluate the suggested BPR methodology in terms of decisions taken during the process (problem solving) and of potential business benefits arising from the implementation of the model's eight stages (improvement).
- *Organisational effectiveness*: The representatives of each participating company were asked to examine and report how their organisation responds to the suggested model and what are the required organisational changes that their companies should follow in order to adapt themselves into the new system suggested by CONDOR

- *User acceptability*: Apart from the organisational effectiveness the three case studies tried to evaluate the user's responses to the new implementation strategies using the CONDOR BPR model

Finally, the evaluation is conducted for all the project end-users, based on the eight stages of the CONDOR BPR model presented in chapter 7 (practical applications of the CONDOR BPR model). The following section explores the relationship between the evaluation and organisational learning and innovation within a business process re-engineering context.

8.4 Organisational learning and innovation

This section aims not at giving an extensive literature review on organisational learning and innovation but at defining these two concepts and discussing their relationship with evaluation and business process re-engineering according to the research objectives of the current thesis. It has to be noted here that the analysis and discussion of the above relationships is a fairly new area of enquiry and, as a result, there is not much supporting evidence in the literature.

As was discussed in chapter 3 (research questions), many of the problems of the construction sector lie in its inability to learn quickly. Organisational learning is "*the process of improving actions through better knowledge and understanding*" (Fiol and Lyles, 1985). Learning is organisational to the extent that a) it is done to achieve organisational purposes, b) it is shared or distributed among members of the organisations, and c) learning outcomes are embedded in the organisations' systems, structures, and culture (Snyder and Cummings, 1998).

Although the nature of organisational learning depends on one's definition of an organisation (Jashapara, 1993), Argyris and Shon (1996) have developed two notions of organisational learning, single-loop and double-loop learning which cuts across the organisational definitions. Single loop learning is where individuals respond to changes according to the demands of their internal or external environment by detecting and correcting their errors in order to maintain the central features of the organisational norms and purposes. Double-loop learning on the other

hand, is related to the process of questioning the current organisational norms and assumptions in order to establish a new set of norms.

Innovation is a product of organisational learning (Cayer, 1999). Innovation can be defined broadly as "*an idea, a product or process, system or device that is perceived to be new to an individual, a group of people or firms, an industrial sector or a society as a whole*" (Rogers, 1995). Innovations can occur in three broad domains: product, process and organisational. According to the research objectives of the current thesis, the innovation is discussed from a process and organisational point of view. Process innovation refers to the "*adoption of new or significantly improved production methods*" (Neely and Hii, 1999). Organisational innovation refers to "*the 'introduction of new approaches to managing or organising the firm*" (Neely and Hii, 1999).

In a continuously changing and increasingly turbulent environment, organisations are becoming more interested in new ways of gaining and sustaining a competitive advantage. According to Drucker (1988) knowledge is the only lasting resource of competitive advantage. According to Edmondson and Moingeon (1998) organisational learning and innovation are considered 'intangible' resources because they are very difficult to imitate. Such resources constitute a kind of 'capital' for an organisation which is a source of competitive advantage. Therefore, companies are trying to use organisational learning and innovation in order not only to solve existing problems but also to continuously improve their status in the face of changing conditions.

Organisational learning and innovation is particularly important within the construction industry (Boyd and Robson, 1996). As discussed in chapter 3 (research questions), there are some recent reports which indicate the major weaknesses of the sector, such as poor performance and under capitalisation (Egan, 1998; Latham, 1994), highlighting the need for change and improvement. Moreover, Groak (1994) argues that the need for learning becomes even more important within the construction sector because the use of 'lessons learnt' coming from projects affects the quality of the final product. Furthermore, the under achieving status of the industry indicates an urgent need for improving existing processes and working

practices by introducing new ways of increasing the efficiency of existing processes and by introducing new ways of managing the organisation.

According to Snyder and Cummings (1998), organisations' abilities to change and continuously re-designing business processes are necessary for survival. This capacity of change and re-engineering is associated with organisational learning. Organisations have to be able to learn from past experiences, effectively use 'lessons learnt', correct errors and disseminate this knowledge within the organisation in the organisation if they are to change and adapt themselves to the continuously changing market.

Within this context, evaluation of the change and re-engineering process is crucial. According to Forss et al., (1994), evaluation is by definition connected with change and learning through feedback. The Canadian Evaluation Society (1989) has suggested that evaluation can have many purposes such as information gathering, monitoring, policy making etc. In a business process re-engineering context, evaluation can be used to diagnose weaknesses, set priorities, and facilitate communication and decision making.

Unfortunately there is inadequate evidence in the literature regarding the relationship between evaluation of business process re-engineering implementation and organisational learning and innovation. The researcher has used the existing evidence in order to support the formulation of the research questions 3a and 3b (chapter 3, research questions). The following section presents the evaluation results of the BPR implementation strategies of the three case studies. This exercise will explore the relationship between the evaluation of BPR implementation strategies and organisational learning and innovation, which may lead to the clarification of these concepts.

8.5 Evaluation of JMBygg's implementation strategy

8.5.1 Stage 1: Develop vision and objectives

The main concern expressed by JMBygg at this stage was to improve their document management practices in order to reduce their costs on projects and raise their productivity. The vision expressed initially while writing the CONDOR proposal has been revised and refined in the light of discussions and brain storming sessions with the end-users involved directly in JMBygg's daily business processes. The requirement to focus on end-users, as opposed to pure business processes, has clearly been identified. This corroborates the findings from the quantitative and qualitative research results, conducted by the researcher and presented in chapters 5 (quantitative results) and 6 (qualitative results).

Therefore, JMBygg made the decision to more closely involve the end-users in the process re-engineering initiatives and take into account end-users' suggestions on the deployment of the new system. As a result, a decision was also taken to offer better support to end-users through improved and adapted training in order to increase the number of people that can potentially use the system. This should take place prior to the deployment of the new system. In addition, commercial tools have been identified to support and complement the search capabilities proposed by CONDOR.

The evaluation of the implementation of the CONDOR BPR initiative also revealed that concentrating solely on JMBygg's internal business processes would not bring the expected potential benefits. JMBygg has realised the need to integrate their existing systems and knowledge bases with those of their collaborative partners, as part of a more global strategy. Finally, JMBygg has commented that, although the overall aim of a project or operation is well explained to the parties involved, during the business process re-engineering, it is essential to break the aims and objectives into more understandable pieces and communicate them effectively. This is one successful way of involving the end users in the change process as a way of reducing resistance to change.

8.5.2. Stage 2: Understand Existing Processes

JMBygg has faced many challenges during the past few years due to changes in the legislation in Sweden and due to increasing demand for improved services and products from the customers. They realised that these two factors make the competition even harder and in order to survive they have decided to focus on quality, marketing, safety and project planning for every building project regardless of its size and potential profit. Within this context, the role of business process re-engineering is crucial. They have recognised the importance of an effective document management system because the amount of information can affect the speed of the building process, and as a result the quality of the final product. They have also acknowledged the limitations of their current system, as stated in their report on their current business processes:

> *"Today our document handling system is only used in building projects; it is a closed system without any connection to information at other levels. The next generation of systems must be part of the company's total information handling system, with connections to open technical platforms like the Intranet and Internet".*

Understanding of current processes is an important factor in order to attempt a re-engineering work, as described in chapter 7 (practical application of the CONDOR BPR methodology). However, the researcher feels that the lack of a recognised process description methodology was a limitation to the sound understanding of the important aspects of JMBygg's business processes. In fact, as explained in chapter 7, it was proposed to make use of IDEF0 for process activity modelling. JMBygg didn't feel comfortable with this methodology, and instead they produced an overall flow chart diagram that describes their entire project processes, from the market research to the delivery of the finished product. The information included in the flow chart diagram originated from the end users involved in the interviews.

JMBygg felt that the end-users' support was very positive, and that they did provide valuable information regarding not only the description of the processes but

also the time frame, the actors involved, and finally the various activities involved. In addition, other flow charts have been produced in order to describe sub-processes and related actors. The extensive mapping of JMBygg's processes and EDM investigations has brought forward a number of suggestions regarding not only the business process re-engineering initiative but also the overall organisational change.

8.5.3 Stage 3: Identify process for redesign

The interesting aspect of this stage is the early identification of the role that the Intranet along with the Internet can potentially play in improving the communication between the non co-located actors on projects, by giving them an integrated access to the project documentation.

According to JMBygg, there are very important advantages regarding the use of the Intranet and Internet, including those to:

- Provide means of connecting consultants and suppliers while reducing their communication costs by up to 80 per cent. These groups can both retrieve public information from, and upload their documents to JMBygg's central document servers.
- Improve the accessibility to suppliers' product information.
- Improve the process of calling in/ordering of deliveries.
- Provide the ability to check the production and transport status of goods on order.
- Support and facilitate the electronic payment of goods.
- Provide access to information resources and suppliers from other countries.

As a result, JMBygg's current document management software has been extended and made Internet compliant. This provides a 'low entry level' tool and a unique opportunity to JMBygg's partners to have access and share documents. The only requirement is to have a web browser. In addition, it was suggested that a web site would be developed and maintained to act as a central gateway, and give JMBygg's end-users access to a variety of functionality, including e-mail systems. These services are already under development by an information broker, the Swedish

Document Bank. The latter is a company owned by a Swedish consortium that provides secure access to documentation stored on their document servers.

As a result of the deployment of the BPR model, JMBygg has also recognised the importance of replacing the old organisational hierarchies with horizontal multidisciplinary teams, where all members are encouraged to participate more actively in the business processes. The aim is to increase the sense of responsibility and understanding through the participation and empowerment of the end-users. The latter must learn how to use the proposed systems and provide continuous feedback, while the IT managers must spread out the best practices and raise the number of potential users through training.

In addition, JMBygg realised that the company's agreement with consultants was not very efficient. They are now aiming at long term agreements with their consultants and partners as part of their project management and planning activity. Finally, JMBygg decided to emphasise the integration of the company's resources and knowledge with those of their partners.

8.5.4 Stage 4: Identify change levers

The evaluation of the above stages has shown that business process re-engineering is not an isolated process. On the contrary, the change process involves human and organisational issues such as, in the case of JMBygg, the replacement of organisational hierarchies with multidisciplinary teams, and the need for the involvement of end-users and process owners throughout all the stages of the re-engineering process. The end-users should feel comfortable with the new system. An opportunity should be given to them to learn and familiarise themselves with it.

It has also been recognised that the implementation of a new system may create resistance to change. JMBygg's IT management team has, therefore, decided to improve communication and offer training not only at the beginning of the change process but also during the re-engineering effort. Moreover, JMBygg has decided to promote team working as an important requirement for successful process re-engineering and organisational change. JMBygg is also trying to integrate process

owners more closely in the change process and encourage them to participate in decision making regarding the new business processes and the new organisational functions that surround them.

8.5.5 Stage 5: Implement the new process

This stage is concerned with the implementation of the identified candidate processes for re-design. As explained in section 7.10, these identified processes have been implemented by extending the EDM systems in use. This was done by implementing a subset of the CONDOR API functions supporting these processes. One might argue that an implementation of business processes based exclusively on IT tools might divert the BPR team from the essence of the re-engineering work and hide important aspects in relation with process, culture and organisational behaviour. The researcher has identified this risk, and tried to address it within the proposed BPR model. According to JMBygg representatives, stages 6 (Make new process operational) and 7 (Evaluate the new process) of the proposed BPR model provide an initial answer to this problem.

8.5.6 Stage 6: Make new process operational

JMBygg has pointed out that an incremental approach to BPR is more appropriate to their business objectives, needs, and processes. As a result, the CONDOR solutions are implemented and deployed following a 'step-by-step' approach. The evaluation of this stage revealed, as mentioned earlier, that an effective implementation of the re-designed processes must be done in a real business context and environment if sensible results are to be obtained. Moreover, the involvement of JMBygg's business partners, including suppliers, is essential. Instead, scenarios have been developed on real projects to simulate the real business process climate. The researcher views this as a limitation for this stage.

8.5.7 Stage 7: Evaluate the new process

JMBygg regarded this stage as very critical for the evaluation of the new processes that have been implemented within the field trials. It was expected that this evaluation would lead to a justification of JMBygg's objectives regarding time,

efficiency, resources, and profit. In addition, JMBygg felt that the evaluation of the re-designed processes would serve as a guide for other construction projects which are at the moment based on the previous system.

8.5.8 Stage 8: Ongoing improvement

Process improvement was identified as being crucial and classified as a top priority by the JMBygg. The development of the web-based EDM system Eureka!WWW is crucial to the success of JMBygg's new vision. The CONDOR project has impacted on the company's way of storing and retrieving information. This change led to the improvement of JMBygg's IT infrastructure, and helped in the creation of a secure Internet environment.

8.6 Evaluation of Kvaerner's implementation strategy

8.6.1 Stage 1: Develop vision and objectives

The main goal of Kværner through their involvement in CONDOR was to create an innovative and forceful development of their entire organisation, employees, proprietary technology, and business processes. According to Kvaerner:

> *"That position will be maintained by valuing technological creativity and innovation, by utilising the group's unmatched geographical reach and by nurturing an innovative spirit throughout the organisation and among its employees".*

Kvaerner representatives have acknowledged the impact that the very competitive environment of the construction industry is having on their daily processes. Efforts to develop new proprietary technology have been intensified in all core areas. Kvaerner's business strategy is now driven by the need for innovation. The commitment to innovative thinking in all parts and within all disciplines of the organisation is underlined by a central award programme for cutting-edge ideas and creative initiatives. This is the reason why the company constantly invests in new technological developments and participates in research projects such as CONDOR.

Moreover, key players within Kvaerner have pointed out that although business strategy and business vision are topics which are discussed in meetings at a senior management level, the practice has shown that it is difficult to define and analyse these concepts and even more difficult to establish a common understanding between the involved parties. Consequently, Kvaerner has decided to arrange meetings aimed at explaining the links between the business process re-engineering and the overall business strategy in order to involve the end users more closely in the change process.

8.6.2 Stage 2: Understand existing processes

As mentioned in chapter 7 (practical application of the CONDOR BPR methodology), Kvaerner uses a document controller to manipulate, pass and distribute documentation. This provides a collection of services. For instance, the document controller maintains some form of drawing control that keeps track of drawing information, complemented with various functions, including approval, receipt acknowledgement, and document distribution. The document controller also manages correspondence (which handles incoming and outgoing mail) and an information control service (which handles information requests from the system).

The application of the second stage of the CONDOR BPR model showed that the Kvaerner system is not integrated with the commonly used construction applications. This was reported by the end-users as being a major constraint as the documentation produced from these applications is not visible to the document management system. This stage also proved to be fairly complex as the Kvaerner processes were not easy to comprehend. In addition, identifying the limitation of these processes was not an easy task; the end-users tend to accept their current work arrangements and come up with *ad hoc* solutions to potential limitations.

This overall complexity required a co-ordinated effort between the researcher and the Kvaerner end-users in order to clarify the functions of each document management process, and identify its potential weaknesses. The analysis also revealed that the employees working for the Kvaerner IT department did not have a

sufficient understanding of human, process, and organisational issues. The researcher has, therefore, approached and collaborated directly with the end-users involved in the document management practices in order to identify the critical processes for re-design, as described in the next section.

8.6.3 Stage 3: Identify processes for redesign

Having understood the existing processes along with their weaknesses, the researcher along with representatives from Kvaerner have identified the following processes for redesign presented in the table below (Table 8.1).

1. The process of managing and recording pre-contract work.	2. The process of searching and locating information and documents across both live and archived information.
3. The process of training and product information dissemination.	4. The process of traceability of document issue and retrieval.
5. The process of information and document receipt.	6. The process of giving accessibility to information whilst maintaining required security
7. The process of information and document approval and comment.	8. The process of data entry.
9. The process of archiving information and documents at all levels: company; contracts; documents, etc.	
10. The process of the distribution of information and documents across partners involved within a project.	

Table 8.1: Identification of Kvaerner's processes for redesign, Rezgui, 1998

Kvaerner's representatives pointed out that the use of a process description methodology, namely IDEF0, gave them the opportunity to better comprehend their document management practices. They have acknowledged that the use of a methodology provides not only means of codifying experience and knowledge but

enables the organisation to have a clear picture of their current business processes. Therefore, they argue that a methodology should be considered as a pre-requisite for a successful implementation of the third stage of the CONDOR BPR model.

8.6.4 Stage 4: Identify change levers

A successful implementation of a business process re-engineering strategy must be based on the effective use of information technology as well as the understanding of end-user's needs and organisational requirements. The evaluation results identified a crucial need for effective training within Kvaerner. The researcher argues that training will give the employees the required knowledge and the skills to accept and use the whole potential of the enhanced, CONDOR compliant, system. This will facilitate the change process. In fact, a successful change management strategy is crucial for Kvaerner in order to survive and grow in the increasingly competitive environment characterising the construction sector within and outside the UK.

Representatives from Kvaerner mentioned the need to involve the end-users in the design and implementation process. They acknowledged that the exercise consisting of identifying the change levers was worthy because some of the end-users, with many years experience of the current system, were able to contribute their valuable knowledge and become involved in the process. In addition, a common understanding was established which facilitated co-ordination and communication among the involved parties.

Finally, Kvaerner has nominated a committee of business people to review the requirements for document management. This select committee meets regularly to discuss the business direction with regards to document management. Whilst these people are aware of both CONDOR and the IT development projects, they feel that more benefit would be gained by making abstraction of the IT related issues, thus allowing the businesses to focus on what is required rather than on what IT can provide. This decision was based on the findings of the current study that revealed the existence of conflicts between business and IT employees. This will have to be

solved in order to create the 'appropriate' climate that will support the change process.

8.6.5 Stage 5: Implement the new process

It is worth mentioning at this stage that Kvaerner has not been allocated resources to extend their EDM system in order to become CONDOR compliant. This was decided during the preparation of the CONDOR proposal. The aim of Kvaerner was to benefit from the lessons and experiences learnt and acquired in the light of the implementation and extensions to JMBygg's and DERBI's EDM systems. The proposed inter-working and semantic linking services have been carefully analysed by Kvaerner. The latter concluded that while the inter-working services were found to be important, the semantic linking services didn't generate the expected interest and enthusiasm among the end-users.

Furthermore, Kvaerner has acknowledged the importance of the incorporation of the technological developments suggested by CONDOR to the company's existing processes and operations. Despite the lack of financial resources (as explained previously), Kvaerner considered at some point extending their proprietary system at their own expenses. It was felt, however, that the implementation process might become very complicated. Finally, it was decided to delay the extension of the Kvaerner system and concentrate more on the CONDOR technical infrastructure, and organisational and user requirements.

The researcher has realised throughout this evaluation the role that effective and strong leadership can play in the change process. The senior management team has to be committed in order to drive the change forward. This is the precise reason behind the failure of many BPR projects due to the lack of motivation and commitment of the management staff to change.

Kvaerner has identified in this stage a set of 'candidate' processes for re-engineering. These are currently undergoing review and re-design. They include management of pre-contract work, training product information dissemination,

information and document receipt, distribution of information and documents across partners involved within a project, and information accessibility.

8.6.6 Stage 6: Make the new process operational

Although Kvaerner did not take an active part in the implementation of the proposed CONDOR functionality by extending their proprietary system, the company was heavily involved in the field trials. Kvaerner has indicated that the re-engineering process has to be incremental and based on the features of the existing system. This bears similarities with JMBygg's implementation strategy, and will be discussed in chapter 9 (conclusions and synthesis of results).

8.6.7 Stage 7: Evaluate the new process

Kvaerner has tried, on the basis of the understanding of the proposed CONDOR functionality, to assess the impact that a CONDOR compliant EDM system would have on their current business processes in terms of process effectiveness and cost savings. They have also benefited from the project through the various lessons and experiences learnt, including:

- Experience in understanding the effort involved to produce a plug-in to gain access to the electronic services provided by the software producers, as part of the CONDOR project.
- Business Process Re-engineering research and recommendations.
- Understanding the advantages of sharing information and knowledge within Kvaerner, but also on projects.
- Document and Process models developed within the project.

In fact, as mentioned previously, Kvaerner Construction Group Limited has held a long term vision of creating a "paperless project". The Kvaerner employees involved in CONDOR have made some simple calculations, based on their document management requirement knowledge, in order to estimate the cost savings resulting from the adoption of the CONDOR approach. In order to enable a typical construction project to proceed, it was estimated that £22000 would be required for

the purchase of computer equipment in order to deploy a CONDOR type solution. According to Kvaerner's estimation the potential cost savings can be summarised as follows:

- The anticipated document flow on one contract, based on actual contract records, has been estimated to a total of 20,000 documents. Typically it can be assumed that each document has an average of 4 pages which leads to a total of around 80,000 sheets of A4 paper. Given the assumption that each A4 copy costs between 7p and 10p, and if only 1 copy per document is saved, the true cost saving would be around £5,600 to £8,000 per contract. The actual size of the project team, for the example from which these figures were ascertained, is a core of 15 and the average number of copies required per document is assessed at 5. The full potential savings after implementation of the system is therefore £28,000 up to £40,000. By averaging these figures out we can therefore safely assume a minimum saving in copying costs of £6,800 and a potential saving of £34,000.

- Archiving the contract documents is also an expensive exercise. Most Kvaerner project documentation is archived in the company's available office space. There will come a time however, when no further space is available at the office and storage space will have to be rented. This is typical of other projects of the company. Current cost savings in terms of archiving are therefore restricted to the cost of archiving materials and the associated archiving labour costs. Material costs for 80,000 copies can be assessed at around £100. Labour costs can be estimated at being around 2 weeks for 1 person, which represents an average amount of around £500. This gives a total cost of £600. These savings however need to be set off against the cost of CD storage which for this example would be the cost of 15 CD's: approximately £75.

The overall potential savings can therefore be summarised as follows:

Description	**Expenditure**	**Saving**	**Net Saving**
Capital Equipment	22000.00		-22000.00
Photocopying	0.00	34000.00	34000.00
Filing	0.00	600.00	600.00
Archiving	75.00	600.00	525.00
		Potential Savings	**£13125.00**

The above savings are for one project. It can be assumed that they can be repeated on each and every similar sized project.

The representatives from Kvaerner involved in the evaluation process stressed the fact that cost effectiveness is a crucial success factor in a change process. However, the company has to identify potential risks related with the implementation and the use of the new processes in order to avoid being exposed to unnecessary risks and expenses.

8.6.8 Stage 8: Ongoing continuous improvement

The representatives of Kvaerner who participated in the evaluation process acknowledged the fact that business process re-engineering is an incremental and ongoing process. They intend to use the CONDOR results and to implement them incrementally as part of their global strategy.

8.7 Evaluation of DERBI's implementation Strategy

8.7.1 Stage 1: Develop business vision and process objectives

DERBI faces similar challenges to JMBygg and Kvaerner. They have to survive in a competitive and continuously changing environment in France, characterised by increasing market pressures. They constantly need to improve the quality of their services and products in order to meet the requirements of their

clients and remain competitive. Therefore, DERBI has concentrated on the improvement of their document production and management practices. They have acknowledged that research and development projects, such as CONDOR, give them a unique opportunity in that respect. In addition, they have mentioned the potential benefits gained from a European co-operation where the collaborative partners exchange lessons and experiences.

8.7.2 Stage 2: Understand existing processes

During this stage, DERBI re-examined their current processes in order to identify their potential weaknesses and limitations. They emphasised the importance of documents: *"documents constitute the spinal chord of construction projects"*. They are used as the main media to convey and exchange data, information, and knowledge on projects. This explains the crucial role that document quality plays within DERBI as well as their holding OTH. Figure 8.2 depicts the relationship between the partners involved in a project, as reported by DERBI. The nature of these relationships proved to be fairly complex and requiring improved communication support.

DERBI has identified within this stage several major weaknesses preventing the company from improving their document management practices and productivity. DERBI has pointed out that their current system was not reliable, and in some cases could not effectively support some of their complex projects leading to important delays in document and product delivery. The latter leads to a lack of co-operation between the project actors, a lack of understanding, and important delays in information and document delivery. As a consequence, this overall climate generates tensions and conflicts between the project partners, including the client.

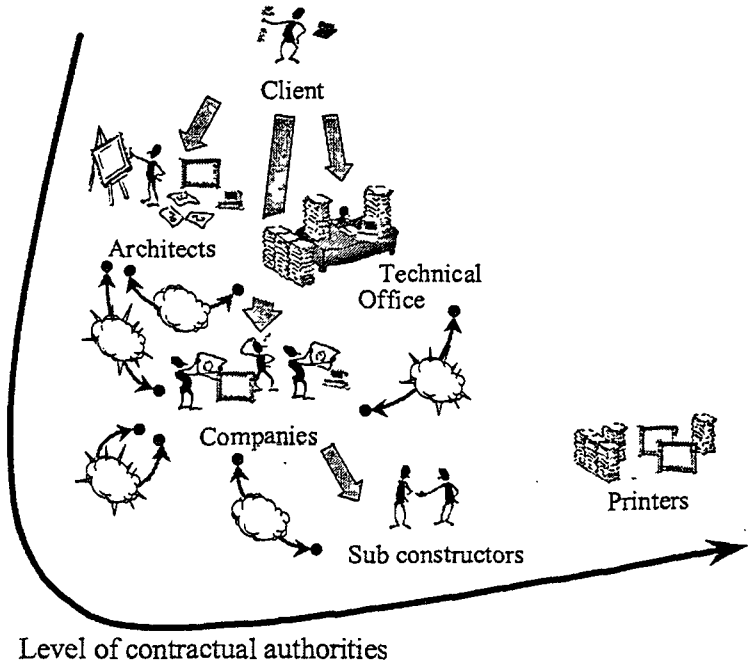


Figure 8.2: The level of contractual authority on projects as described by DERBI, Raffalli and Daussy, 1997

8.7.3 Stage 3: Identify processes to redesign

The representatives of DERBI involved in the evaluation process of the suggested BPR methodology have acknowledged that analysing and modelling their current business processes and document management practices was a crucial stage in that it gave them an opportunity to identify critical processes for re-engineering.

The main weaknesses identified by DERBI during this stage were with regard to the internal consistency of their documentation. Major problems have been identified as a consequence of a lack of semantic control of the information contained within documents. As mentioned previously, documents are treated as 'black boxes'. The document management practices analysis conducted in stage 2 revealed that their documents present a great deal of redundancy and often lack structuring. This overall context has often resulted in information inconsistencies, business process inefficiencies, and change control and regulatory compliance problems. Therefore, a major demand from the management staff of OTH (the main holding of DERBI) has been expressed in order to improve the quality of the produced documentation. In addition, the researcher has identified a major limitation during this stage. In fact, DERBI has a dominant position in the

Construction EDM market in France. They didn't show much interest and enthusiasm in the inter-working functionality proposed by CONDOR. In fact, they are used to impose contractually their SGT EDM solution within their projects. It took them a while to realise that a solution promoting the use of several EDM solutions within a project doesn't constitute a threat to their proprietary solution. It also took, the research team, several months to convince DERBI who eventually seemed to agree with the position of the consortium.

During this stage, DERBI has highlighted the fact that there is very little co-ordination between their end-users. For instance, there is no formal support for change notification. This prevents the end-users from taking changes into account in due time, and as a consequence results in major inconsistencies in their documentation. Process and people co-ordination was identified as a weakness within their company.

8.7.4 Stage 4: Identify change levers

DERBI has recognised the importance of an incremental approach to BPR. The company has stressed the fact that although its existing system needs improving, the company's current operations cannot change rapidly due to costs and time constraints. DERBI has also identified some of the capabilities of the CONDOR system as crucial and the company is in the process of incorporating them into their current projects. In this effort, the company has pointed out that the new developments, such as the implementation of the semantic linking functionality, will lead to improvements in quality and efficiency.

DERBI has followed the research which took place within JMBygg and Kvaerner. They have been informed about the problem they had to face as regards resistance to change from their employees. As a result, DERBI has decided to involve more closely both their senior and technical management teams in the decision making process. It was also interesting to notice that the employees from DERBI didn't identify training support as a critical success factor for BPR. This can be explained by the fact that DERBI puts a lot of investment in training. They are themselves a certified training body, specialising in AutoCAD and other commonly used applications in the construction industry. The whole staff from DERBI, and

more generally OTH, seem to have benefited from these efforts put into training and staff technical support. The researcher was very pleased with this aspect.

8.7.5 Stages 5 and 6: Implement and make the new process operational

Representatives of DERBI have recognised the importance of the implementation phase. Having adopted the incremental approach to business process re-engineering, DERBI has decided to implement a subset of the proposed CONDOR functionality through extensions to the SGT system.

The research team had to face some problems as regards the application in a real context of the improvements made to SGT. DERBI didn't feel comfortable with developing a field trial based on a real project. They expressed major concerns about having to interfere with ongoing projects by making their improved processes operational. They preferred to concentrate on the development of a demonstrator that made use of real documentation taken from an ongoing project: the Guimet Museum.

The researcher argues that a demonstrator based on fictitious scenarios does not give a complete picture of the re-engineered processes. Also, it does not allow the identification of potential risks and limitations of the re-designed processes. However, DERBI has done its best to benefit from the lessons and experiences learnt from the field trials conducted by JMBygg and Kvaerner.

8.7.6 Stage 7: Evaluate the new process

In the same way as Kvaerner, DERBI has done some basic calculations in order to estimate the cost savings and return on investment resulting from the adoption of the CONDOR approach. This is summarised in the table below. The figures are expressed in French Francs.

Year	97 - 98	99	00	01	02	03
Total savings	**- 301 000**	**- 331 000**	**- 286 000**	**- 116 000**	**74 000**	**264 000**

The table shows that the first return on investment is to be expected in 2002. By this time, DERBI would have to invest in the re-design and improvement of their information and document management practices based on the extensions to their SGT system.

In addition, the technical team from DERBI acknowledged that the use of CORBA was a worthy experience. In fact, the combination of two technologies: the Internet (as a communication media), and CORBA (as a middleware supporting inter-working between applications), revealed to be a very promising experience. DERBI is about to release the Internet version of SGT. This advanced EDM system is expected to give the whole OTH group a substantial competitive advantage in the French construction market.

8.7.7 Stage 8: Ongoing continuous improvement

The representatives of DERBI emphasised the importance of continuous improvement which is already incorporated into their overall business strategy. Finally, they mentioned that their policy based on training and staff support will be pursued, and that their employees will be more closely involved in the future in all decision making regarding their daily practices.

8.8 Summary of evaluation results

This section aims at giving a summary of the evaluation results. The three case studies of the current thesis evaluated the business process re-engineering which took place within the CONDOR project. The representatives of each company were asked to provide information on what really happened during the implementation of the CONDOR BPR methodology. As a result, the representatives described the decisions that their companies made in order to adapt to the change process and the potential benefits that they expect in terms of business performance improvement, organisational effectiveness and user acceptability. The evaluation results are categorised as 'facts' and 'actions'. The first category explains how the companies

did benefit from the re-engineering process. The second category presents future actions that the company will take as a result of the BPR implementation. The evaluation of BPR implementation revealed that there is also a third category which combines 'facts' and 'actions'. A summary of the evaluation results is presented in the following table (Table 8.2).

	Business performance improvement	**Organisational effectiveness**	**User acceptability**
Develop Business Vision and Objectives			
JMBygg	➢ More global strategy (A)[1] ➢ Assessment of the existing competition (F)[2]	➢ More training (A)	➢ More focus on end users (A) ➢ Involvement of users in the design of the new processes (F) ➢ More support to the users (A)
Kvaerner	➢ Understanding the role of innovation (F) ➢ Emphasis on the importance of the participation in research projects (F) ➢ Understanding of the market's competitive forces (F)	➢ Improved communication (F)	➢ Emphasis on end users involvement (A)
DERBI	➢ Acknowledgement of the importance of participation in research projects (F) ➢ Understanding of the market's competitive forces (F)		
Understand Existing processes			

[1] (A): Actions
[2] (F): Facts

JMBygg	➢ Acknowledgement of the limitations of the current system (F) ➢ Production of a flow chart diagram (F)	➢ Acknowledgement of the importance of an effective document management system (F)	➢ Involvement of the end users in the description of the processes (F)
Kvaerner	➢ Acknowledgement of the limitations of the existing system (F)		➢ Emphasis on user's involvement in the process (A)
DERBI	➢ Understanding of the limitations of existing processes (F)	➢ Assessment of the impact of the limitations of the existing processes on organisational effectiveness (F&A)	
Identifying existing processes			
JMBygg	➢ Early identification of the role of Intranet and Internet (F) ➢ Emphasis on integration of company's resources with those of its partners (A)	➢ Multidisciplinary teams (F&A) ➢ Flat organisational Structure (F&A)	➢ More participation and empowerment of the end users in the business processes (A)
Kvaerner	➢ Use of IDFE0 methodology (F) ➢ Identification of the limitations of the existing processes in a more consistent way (F)	➢ Improved communication and co-ordination (F)	➢ Acknowledgement of the contribution of the end users in the identification of the processes for redesign (F)
DERBI	➢ Identification of processes for redesign (F)		
Identify change levers			
JMBygg		➢ BPR is not only technology driven ➢ Acknowledgement of the importance of organisational and human issues involved (F)	➢ Acknowledgement of the danger of resistance to change (F) ➢ More training (A) ➢ Involvement and empowerment of

		➢ Emphasis on teamworking (F&A)	the process owners (A)
Kvaerner		➢ Understanding of the importance of the organisational requirements in the change process (F) ➢ Emphasis on the need for training (A) ➢ Emphasis on the effective change management (A)	➢ Emphasis on the end users involvement and empowerment (F&A)
DERBI	➢ Emphasis on the incremental nature of BPR (F&A)		➢ More involvement of technical people and senior management in the change process (F&A)
Implementing the new process			
JMBygg	➢ Emphasis on a holistic approach to BPR (F&A)	➢ Emphasis on organisational culture (A)	➢ Acknowledgement of the danger of resistance to change (F&A)
Kvaerner	➢ Adoption of the incremental approach to BPR (F&A) ➢ Emphasis on the 'step-by-step' approach to implementation (F&A) ➢	➢ Emphasis on the commitment of the senior management (A) ➢ Emphasis on the need for strong leadership in order to take the change forward (A)	➢ Acknowledgement of the danger of resistance to change in case of radical implementation (F&A)
DERBI	➢ Adoption of the incremental approach to BPR (F&A)		
Make the new process operational			
JMBygg	➢ Adoption of the incremental approach to BPR (F&A)		
Kvaerner	➢ Emphasis on the incremental approach to BPR	➢ Acknowledgement of the danger of organisational	

	(F&A)	ineffectiveness in case of radical implementation and use of the new processes (F&A)	
DERBI	➢ Identification of potential risks and benefits (A)		
Evaluate the new process			
JMBygg	➢ Acknowledgement of the importance of the process evaluation (F&A) ➢ Use of the evaluation results in other projects (A)		
Kvaerner	➢ Estimation of potential savings (F) ➢ Identification of potential risks (F&A)	➢ Improved information sharing (F)	
DERBI	Estimation of potential savings (F)		
Ongoing continuous improvement			
JMBygg	➢ Acknowledgement of the importance of continuous process improvement (F&A)		
Kvaerner	➢ Acknowledgement of the importance of the 'ongoing' nature of BPR (F&A)		
DERBI	➢ Acknowledgement of the importance of continuous change process (F&A)		➢ Continuous support for the end users (A) ➢ More training (A)

TABLE 8.2: SUMMARY OF EVALUATION RESULT

Chapter 9

Conclusions and synthesis of results

This chapter presents and discusses the research results of the current thesis. It also analyses the contribution of the thesis to the business process re-engineering research through the discussion of the research questions. This chapter finishes with the analysis of the limitations of the current thesis and the recommendations for future research.

9.1 Introduction

This chapter explores the importance of the empirical work presented in chapters 5 (quantitative analysis and results), 6 (qualitative research), 7 (practical applications of the CONDOR BPR model), and 8 (evaluation of implementation strategies), and synthesises these results in order to explore and discuss the answers to the research questions of this thesis. In this framework, the contribution of the present thesis to the business process re-engineering research will be discussed. In addition, the chapter discusses the limitations of the study, and presents the recommendations which will serve to give both theoretical and practical guidance for future research in the field of business process re-engineering in the construction industry.

9.2 Discussion of the research results and contribution to BPR research

The following section presents a synthesis of the findings arising from the empirical work of the current study. It aims at discussing the research questions presented in chapter 3 (research questions) and at presenting the importance of the findings of the empirical work, which constitutes the contribution to knowledge of the current thesis. The following part is divided into the following three sections: a) business process re-engineering, b) business process re-engineering and organisational and human issues, and c) evaluation of business process re-

engineering and organisational learning and innovation. Each section discusses a research theme presented in chapter 3 (research questions).

9.2.1 Business process re-engineering

Throughout the literature review (chapter 2, literature review), the concept of business process re-engineering proved to be somewhat ambiguous. There are several different approaches to BPR which include a number of contradictions (e.g. radical versus incremental). The literature review also revealed that a high percentage of BPR projects fail. Therefore, one of the research themes of the current study was to first develop an appropriate BPR methodology in order to facilitate the change process, and then clarify the concept of BPR through its implementation.

In addition, the critique of existing BPR methodologies presented in chapter 7 (practical applications of CONDOR BPR methodology) showed that there is a need for the development of a new methodology. After analysing the unique characteristics of the construction industry, the criticisms of existing methodologies, and the relevant BPR literature, the researcher developed an eight stage model which was applied and evaluated by the three case studies. The evaluation of the CONDOR BPR methodology is presented in chapter 8 (Evaluation of implementation strategies). Some examples of the evaluation results will be presented here in order to answer the first research questions of the current thesis (How will the study help to define an appropriate business process re-engineering methodology in order to facilitate the change process and enhance organisational effectiveness?).

The evaluation of the business process re-engineering model applied in the three case studies of the current thesis showed that there are several reasons that justify the use of the CONDOR BPR model in order to facilitate the change process and enhance organisational effectiveness. The evaluation of the model suggested that the CONDOR BPR methodology offered a certain level of organisation which facilitated the planning and monitoring of the change process. For example, the stage of identification of the key processes enabled the participants to represent the core processes of their company, identify their weaknesses, communicate the results, and take actions. Also, the participants suggested that this level of organisation clarifies

their roles and tasks which leads to better communication and co-ordination. These improved characteristics enhance organisational effectiveness. In addition, the development of the CONDOR BPR methodology contributed toward putting into perspective key BPR phases such as process analysis, implementation, and evaluation allowing the monitoring of the progress of the re-engineering effort.

The development of the CONDOR BPR model, its use in a practical context, and its evaluation by the three participating companies gave the researcher an opportunity to clarify some aspects of the business process re-engineering concept providing an answer to the research question 1b (How will this study help to clarify the concept of BPR and facilitate its implementation in the construction industry) presented in chapter 3 (research questions).

All the three participating companies suggested that they use an incremental approach to business process re-engineering. The three companies have decided to incorporate the new technological developments into their existing processes. This finding shows that although the concept of business process re-engineering has started as radical, the analysis of case studies revealed that in the particular context of the research the incremental implementation of change is more effective. Despite the intention for a radical organisational change, the implementation was incremental, supported by planning, monitoring and evaluating. In fact, within these three case studies, the incremental approach to BPR was not found to be a barrier to the change process, as suggested in Hammer and Champy (1993).

Another clarification of the business process re-engineering concept referred to the drivers of BPR. As it has been explained in the literature (chapter 2, literature review), there are many approaches to what is driving and enabling the change using business process re-engineering. Some authors have argued that information technology has the dominant role, suggesting the view of re-engineering as being IT driven (Hammer and Champy, 1993). On the other hand, other BPR authors place much less emphasis on IT and promote business processes as being the crucial success factor (Morris and Brandon, 1993). The application of the CONDOR BPR model and its evaluation showed that a more holistic view of the factors affecting BPR is needed. This means that the focus on processes and information technology

is essential but organisational and human issues have a major impact on the re-engineering effort.

Another contradiction of the BPR concept is related to the presentation of re-engineering as a universal or specific management solution. Many BPR authors argued that there is no need to differentiate alternative types of BPR for different application areas such as manufacturing, construction or services because the concept is based on techniques and tools which are appropriate for every sector. On the other hand, there are many BPR writers who argue that the business process re-engineering initiative has to be tailored according to the needs of each business sector. The implementation and evaluation of the CONDOR BPR model suggested that construction companies have some common unique characteristics, such as project teams and temporary construction sites, which have to be considered in the re-engineering process. On the other hand, it has to be noted here that the CONDOR BPR methodology is based on some universal BPR concepts which are applicable to every sector such as process analysis or implementation.

Finally, the researcher feels that another important aspect of the CONDOR re-engineering implementation was the use of a multidisciplinary team of 'reengineers'. The researcher worked closely with key people of the CONDOR project in order to implement organisational change effectively. The members of the team had a different background such as information technology, construction, organisational psychology etc. This diversity was a critical success factor of the whole re-engineering process. The research results have shown that the organisational change should be holistic and this is a reason why diverse skills and knowledge is needed. The researcher feels that it would be impossible to both implement BPR in the participating companies and meet the objectives of the current thesis without the contribution of people with different background.

9.2.2 Business process re-engineering and organisational and human issues

As mentioned in the literature, which served as a basis for the formulation of the research questions (chapter 3, research questions), business process re-engineering focuses primarily on processes and, as a result, organisational and human issues are very often neglected. The application of the CONDOR BPR model in the three case studies and the evaluation of these practices in combination with the research results showed that there are a number of organisational and human issues that need addressing in a business process re-engineering initiative in a construction firm.

Although the construction industry is based on projects, which means that the idea of collaborative working within project teams is not new, the current study revealed that the communication and co-ordination among the members of the teams is fairly poor. The qualitative results (chapter 6, qualitative analysis and results) revealed that there is a lack of co-operation between people working within, or in separate, departments. In addition, there seems to be a conflict between business and IT people, which may potentially constrain the re-engineering process. As mentioned in chapter 6 (qualitative analysis and results), IT professionals don't always understand business requirements, and business people don't always express their requirements effectively in an objective way.

Since business process re-engineering initiative requires the support of multidisciplinary teams (Willcocks and Smith, 1995), this lack of co-operation may affect the change process and can have an impact on the final product/service. As mentioned in chapters 7 (practical application of the CONDOR BPR model) and 8 (evaluation of implementation strategies), the case studies of the current research have already started introducing new ways of coping with the change process such as the introduction of an IT person to the project team for the whole duration of a project (Kvaerner) and the establishment of a more collaborative way of working based on multidisciplinary teams (JMBygg).

As regards the organisation characteristics available in the respondents' companies, the participants gave the highest rating to the 'strong leadership and

motivation' factor. Strong leadership, which will be able to drive and enable the organisational change, has been identified as a critical success factor in the literature. The factors that received the lowest rating are 'clear shared vision', 'participative decision making', 'training and development programmes', and 'policy of recognition and rewards' which according to the literature (chapter 2, literature review) are prerequisites for a successful business process re-engineering project. Consequently, the role of leadership is no longer dedicated to the control and monitoring of the process, but it has to be used in order to facilitate team working and support its functions. Although each construction company has its own organisational culture and management style (Parfett, 1994), effective team working requires a non-autocratic leadership style able to support the teams and facilitate the change process.

Organisational culture is one of the most important aspects of any change process. A number of change barriers have been identified in the literature (chapter 2, literature review) and supported by the quantitative and qualitative research results. These referred to organisational structures and cultures that support management and individual roles rather than teams and processes, strict hierarchical structures, vertical communication, conflicts, accepting the status quo, mistrust and non acceptance of the role of IT.

According to the results coming from the evaluation of CONDOR BPR implementation, a successful business process re-engineering initiative in a construction company must be characterised by flat structures, networked communications, multidisciplinary teams, effective use of IT, management support, employee empowerment and involvement in decision making. For example, JMBygg has indicated during the identification of processes, that multidisciplinary teams and flat organisational structure are needed in order to support the re-engineered processes. In addition, Kvaerner has put emphasis on the end users involvement and empowerment during the identification of change levers.

In process focused organisations, there is an increased risk due to the fact that the employees are learning to cope with new structures, new processes, and the new concept of team working at the same time. According to Wellins and Murhy (1995),

there are a lot of barriers to unsuccessful team implementation which are unclear team missions, interpersonal conflicts and lack of training in new skills and competencies. The empirical work of the current study confirmed that interpersonal conflicts and lack of training could constrain the re-engineering process. More specifically, the respondents found their company's ability to change, the investment in new products and services, and the use of IT facilities, satisfactory. It seems that the participating companies understand the importance of change in order to survive in a competitive environment.

However, the majority of the employees argued that the existing opportunities for training are somewhat satisfactory, while a strong minority (19.5%) believed they are unsatisfactory. This finding is important because the lack of appropriate training can lead to the failure of the business process re-engineering initiative due to a potential risk of resistance to change. Also, an improved IT system can become ineffective in relation to the invested money if the employees do not have the knowledge and the skills to use its full potential. This corroborates the finding from the qualitative analysis. In fact, some interviewees did acknowledge the fact that they don't trust computers for various reasons, including lack of skills, lack of time, and lack of support. They did suggest training as a possible way of addressing the change process. This finding is interesting because business process re-engineering may lead to resistance to change if employees feel that they do not have the required knowledge and skills which will enable them to operate the new system.

In addition, the current thesis showed that it is important to underpin the re-engineering process with an effective involvement in the company's business strategy and vision. It seems that the employees do not understand the need for strategic change in order for their company to survive in a continuously changing environment. A successful business process re-engineering initiative requires the support and involvement of both management and employees. According to the qualitative findings (chapter 6, qualitative findings), some interviewees failed to understand the imperative of change because they weren't involved in, and informed about, their company's strategy and vision and as a consequence weren't committed to change.

Finally, the quantitative and qualitative research has shown that the role of information technology is crucial in the improvement of their existing processes, products, and services, for a number of reasons, including time saving and improved management of information. In fact, the role of information technology in business process re-engineering is well defined and understood among the respondents. However, the last question of the questionnaire (Appendix I) revealed that the future growth of companies in the construction sector relies on both IT and business factors. The respondents pointed out that the following factors are crucial for the successful development of their company: utilisation of existing technologies, development of new technologies, good communication, training, and good management. It seems that the development of the new technology cannot produce the benefits alone. The organisation has to develop effective management tools and methods in order to adapt itself to the competitive market.

9.2.3 Evaluation of business process re-engineering implementation and organisational learning and innovation

This section discusses some examples from the evaluation of business process re-engineering implementation in the three case studies, identifying the role of evaluation in the BPR implementation, indicating its links with organisational learning and innovation, and providing an answer to research questions 3a and 3b (Can the evaluation of the implementation of a business process re-engineering process initiative improve the change process in an organisation? and What is the role of evaluation of implementation of a business process re-engineering initiative in organisational learning and innovation?). The detailed analysis of the evaluation results is presented in chapter 8 (evaluation of implementation strategies).

All the three participating companies concluded that understanding and mapping their existing processes was a crucial stage. This exercise allowed them to realise the weaknesses of the current status of their processes, which led to a more informed decision making regarding the identification of candidate processes for re-engineering. In fact, when the second stage of the model (understand the existing processes) took place, the representatives of the three companies were unclear about

the status of their existing processes. This was mainly due to a lack of documentation describing the company processes and the associated operations. Therefore, the participating companies in the CONDOR project had to map their processes almost from the beginning by making use of a variety of process description methodologies, including IDEF0, as described in chapter 7 (Practical applications of the CONDOR BPR model).

This description gave the three participating companies an overall overview of their processes and facilitated the identification of potential weaknesses. This contributed to improve process and information communication within these companies. At the same time, the companies were asked to map not only their existing processes but also the skills required in order to make these processes operational. This form of mapping led to a more integrated organisational change. Therefore, the evaluation of this stage of business process re-engineering facilitated the change process and led to a better knowledge (organisational learning) of the business processes and of the skills required to operate.

Although the three CONDOR end-users were aware of the overall business objectives of their respective companies, the first stage of the re-engineering process, which was concerned with the development of business vision, allowed them to rethink their mission statements in a more specific and clear way. Also, the three companies suggested that the implementation of the new processes is crucial. In fact, they have pointed out that the implementation phase was more smoothly introduced due to the identification of the core organisational processes and competencies. Although, the CONDOR system architecture was partially implemented, all the companies have highlighted the fact that the implementation phase of BPR should be incremental and based on the features of the existing system. These findings show that the evaluation helped the implementation process which has an impact on the overall change process.

The evaluation of the stage referred to "the identification of change levers" showed that the three companies have concluded that information technology enabled the change process. The new technological capabilities proposed by CONDOR gave a unique opportunity to the companies to re-engineer and improve

their existing processes. In addition to the acknowledged role of IT, the three companies have suggested that some organisational characteristics had to change in order to facilitate change and support the implementation of the new processes. The companies have concluded that this stage was crucial due to the number of supporting concepts which play a major role in the change process, such as people management and organisational characteristics (including culture and structure). They have realised that these characteristics need changing in order to support the new processes. As a result, the evaluation made the change process more effective by identifying its major enablers and allow learning to take place. This led on the one hand, to process innovation, since significantly improved technological capabilities were introduced; and on the other, to organisational innovation, since new approaches to organising the companies were considered.

Finally, the three companies have realised the fact that the organisation has to focus on organisational and human issues involved in the re-engineering process and adapt a 'continuous improvement' approach to change. The role of these concepts is very often neglected in the existing BPR methodologies. This was highlighted during the evaluation work carried out within the three case studies of the current thesis. For example, all the companies have reported the urgent need of training in order to use efficiently the existing skills and competencies and utilise the full potential of the new system in order to increase productivity and improve quality. Also, the analysis of the research results showed that there is a potential danger of resistance to change which might constrain the overall change process. As a result, JM have decided to involve the end-users more closely in the decision making process as well as in the implementation process. This process has increased organisational learning which led to the adoption of innovative ways of managing people.

9.3 Limitations of the research

The discussion of the research findings and the research questions cannot be fully justified without considering the limitations of this study. These limitations will be discussed below.

One limitation of the current study is related to the context in which the research took place. The researcher had the opportunity to develop, use and evaluate the CONDOR BPR methodology in real life scenarios within a European partnership. This opportunity was a very useful learning experience for both the participants in CONDOR and the researcher. On the other hand, the researcher feels that there were some time constraints due to the project life cycle and also research limitations because of the project's aims and objectives. As a result, the researcher had to complete the quantitative and qualitative data collection within a specified timetable suggested by the project co-ordinators. Also, the researcher's suggestion for the introduction of incentives in order to increase the response rate of the quantitative results was rejected by the CONDOR general meeting.

The size of the sample on which the quantitative research was based constituted another limitation of the current thesis. The low response rate, which is a common problem in the social science research, did not allow a more advanced statistical analysis, and as a consequence the quantitative results revealed to be quite limited. Also, the difference in response rates between the two participating companies (50% for Kvaerner and 27.5% for JMBygg) did not allow a more advanced statistical analysis which would enable the researcher to make comparisons between the two companies. The researcher was aware of this limitation and this is the reason why qualitative research methods were used in order to enrich the study's data enabling an adequate analysis and discussion of research themes and questions.

However, the researcher had many difficulties in setting up interviews. She had to conduct phone interviews with the employees of the Swedish construction company due to cost constraints imposed by the project. Also, the French company didn't participate in either the quantitative or the qualitative research. It experienced many difficulties at the time as explained in chapter 4 (research methodology and design). Therefore, the results of both the quantitative and qualitative research should be treated with care.

Although the evaluation of the CONDOR BPR model has shown that the use of the methodology has facilitated the change process and has enhanced the organisational effectiveness within the three participating companies, the researcher

thinks that the eight stages of the model may constrain creativity and innovation of the process development. If a potential user tries to follow the guidelines and the steps of the CONDOR BPR model ignoring the specific and sometimes unique characteristics of a context, a company or a business sector, there is a potential danger that creativity and innovation regarding process development and implementation may be constrained. This will affect and have a direct impact on the change process.

The relationship between evaluation and business process re-engineering is a new area of research. Also new is the relationship between evaluation, organisational learning and innovation. As a result, the literature related to the above issues is limited and the theoretical background able to justify the relationships between these concepts is missing. Although this is expected in a doctoral thesis since it is trying to produce and formulate contribution to knowledge which by definition is new, the researcher thinks that the conclusions drawn based on this study should be treated and used with every precaution due to the lack of other supporting research findings.

The above limitations of the current study are by no means exhaustive. However, whilst this section points out the (potential) shortcomings of the present research, it should not be used to devalue it. These limitations were only realised as the actual research progressed, and thus, from this respect, the present research manages to illustrate the potential problems that can arise, when investigating the area of business process re-engineering.

9.4 Recommendation for further research

The findings of this thesis and its limitations highlight the necessity for further, more detailed research of the issue of the business process re-engineering. Such research will aid identification of the following points:

Other researchers are encouraged to critically examine the CONDOR BPR methodology and test it in other application areas and business sectors such as manufacturing, services etc. Also, researchers or practitioners are encouraged to use this methodology in application areas with different business characteristics such as

SME's etc. It is through such a process that more enriched and improved theories and methodologies evolve.

The research results and the analysis of the case studies have shown that there are some factors related to organisational culture which affect the implementation of the re-engineering process such as networks, flat structure, decentralised communication etc. This organisational culture seems to combine characteristics of the entrepreneurial culture and the evaluation culture described in the literature (chapter 2, literature review). Further research is needed in order to define and measure those factors which affect the relationship between organisational culture and business process re-engineering.

Finally, the relationship between evaluation and business process re-engineering implementation and its links with organisational learning and innovation is a new area of inquiry. More research is needed in order to further develop these concepts and establish their relationships. Organisational learning and innovation are found to be critical success factors in today's competitive market and, as a result, further research is needed in order to analyse those factors which enable an organisation to learn and innovate.

9.5 Conclusions

This chapter presented and analysed the results of the current thesis. It also discussed the contribution of the thesis to BPR research, highlighting its limitations and suggesting directions for further research. The final few words will be left to Machiavelli, whose words the author echoes at every level of the re-engineering process:

> *"It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old institution and merely lukewarm defenders in those who would gain by the new ones".*
>
> Machiavelli, *The Prince*, 1513 A.D

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Appendix I
Sample of the Questionnaire

Dear Sir/Madam,

As you probably know KVAERNER Construction has been involved in a number of European funded projects in order to improve services/products/processes within the Construction Industry using the Information Superhighway.

The current research is one of these initiatives and your assistance would be appreciated. Enclosed you will find a questionnaire which investigates the role of information systems in your job/organisation.

All your answers will be kept strictly confidential and will not be used for any other purpose than for the current project. Please make sure that you answer all the questions.

Thanks for your time and co-operation

Maria Vakola
Research Officer
University of Salford
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Salford
M5 4WT

QUESTIONNAIRE
INFORMATION TECHNOLOGY AND CONSTRUCTION

SECTION 1: GENERAL INFORMATION

1.1) Which company are you working for?

_____

1.2) Which department do you belong to?

IT ☐
Marketing ☐
Human Resources ☐
Commercial ☐
Production ☐
Design ☐
Other _____

1.3) What is your job title?

_____
_____

1.4) What particular project(s) are you involved in right now?

_____
_____
_____
_____
_____
_____
_____
_____

SECTION TWO: INFORMATION TECHNOLOGY AND CONSTRUCTION

2.1) How many networked computers are there in your company?

_____

2.2) How many networked computers are there in your department?

_____

2.3) Do you use computers in your job?

Yes ☐ **No** ☐

If Not please go to Section Three

2.4) How long have you been using computers?

_____

_____

2.5) How comfortable do you feel using computers?

Very much Not at all
1 2 3 4 5 6

2.6) Did you have to change the way you worked when you were introduced to computers?

Yes ☐ No ☐

If yes please specify

_____

_____

_____

_____

_____

_____

_____

2.7) What do you mainly use your computer for?

Word-processing	☐	Spreadsheet	☐
Sending e-mail	☐	Database	☐
Presentation	☐	Internet	☐
CAD/CAM	☐	Presentation	☐

Other_____

2.8) Did the introduction of the new computer system make your job more effective?

Yes ☐ No ☐

Please give reasons

_____

_____

_____

_____

_____

_____

_____

2.9) How often do you use your computer?

Very often Not at all
1 2 3 4 5 6

2.10) Do the computers improve your existing processes/products/services?
Please give an example

2.11) Do you regularly use any particular software?
Yes ☐ No ☐

If yes please specify

2.12) Have you used Electronic Document Management Systems before?

Yes ☐ No ☐
If not please go to the section three

2.13) What specific task did you use Electronic Document Management Systems for?

2.14 a) Do you think that Electronic Document Management Systems are useful?

Yes ☐ No ☐

b) Why?

2.15) What are the main features would you expect from an Electronic Document Management System?

_____

_____

_____

_____

_____

_____

_____

SECTION THREE: BUSINESS ENVIRONMENT

3.1) How do you rate your organisation's effectiveness in the following statements? Please tick the box as appropriate

	Unsatisfactory	Somewhat satisfactory	Satisfactory	Very satisfactory	Excellent
The ability of the business to be responsive to change in a competitive environment is:					
Business's investment in new products and services is:					
Business's policy regarding employees training to new technology is:					
The use of IT facilities is:					

3.2) From your own experience working in your organisation, are these factors available? Please rate them from 1(not available) to 5 (fully in place)

Good communication	
Clear shared vision	
Senior management commitment	
Strong leadership and motivation	
Management-employee participation	
Team-working	
Training and development programmes	
Shared perception of problem	
Participative decision making	

Policy of recognition and rewards	
Customer/stakeholder-focused	
High level of alignment of functional plans and goals	
Project planning expertise	

3.4) What do you think are the main factors that will influence the future growth of your organisation? Why?

_____
_____
_____
_____
_____
_____
_____

SECTION FOUR: CONDOR PROJECT

4.1) Have you heard of the Condor project?

Yes ☐ **No** ☐

If yes please answer the following questions

4.2) Are you involved in the Condor project?
Yes ☐ **No** ☐

If yes in what way

_____
_____
_____
_____
_____
_____

4.3) What benefits are you getting from your involvement in the Condor project now?

_____
_____
_____
_____
_____

4.4) What benefits will you get from the Condor project in the future?

_____
_____
_____
_____

Thank you for your time and co-operation

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Appendix II
Interview Guide

Interview Guide

The purpose of this interview guide is to enable a more detailed data collection regarding the Work Package 3 of Condor project. The questions are designed with the objectives to study the following:

- The role of new Information Technology suggested by Condor in enabling change regarding company's processes
- The role of company's human resource policy in enabling change
- The role of organisational structure and culture in enabling change
- The management of change

1. During the interview, the following points are to be observed
- Stress confidentiality of the interview
- All information obtained from a company will be treated in the strictest confidence
- All the data obtained will only be used for the purposes of the current project

2. The comments in brackets which accompany some of the questions are used to remind the interviewer on the importance of certain words. These words may be of a particular interest to the coding of answers.

Interview Guide

A) General Information

Name of the interviewee: _____
Title:_____
Name of the organisation:_____
Date of interview:_____

A1: Can you please describe the nature of your work?
(State clearly which department it is: marketing, finance, production e.t.c)

A2: Can you briefly describe the nature of your company?
(State clearly: aims and objectives, policies, business environment)

A3: Can you briefly describe the operations and structure of the company?
(Key words: structure, communication, culture)

A4. How would you describe the climate within your company?
(Please stress : relations with subordinates-supervisors-colleagues, communication process, performance appraisal)

A5: Do you use computers in your job? And if yes how comfortable are you with them?
(State clearly: computer training, frequency of computer use, usefulness of computers, main purpose of use)

A6 Did the use of the new technology make your job easier or more effective?
In what way?

A7Could you please specify three major changes that occurred at your work since the introduction of the new technology.
(Please give an example such as e-mail, scanner, EDMS. If the interviewees have used EDMS before, please insist on giving an example related to them)

B)Electronic Document Management Systems and Business Process Re-engineering

B1. Have you used Electronic Document Management Systems before?

B2. What specific task did you use Electronic Document Management Systems for?

B3. Has the introduction of the current EDMS affected the way you used to work? In what way?

B4. Are you satisfied with the current EDMS? Please justify
(Please stress user friendliness and effectiveness)

B5. How did the new EDMS suggested by Condor affect your work?
(If the interviewee was not introduced to new EDMS, please explain the differences between the previous one and the new one and ask him/her to comment on it)

C) Change Process

C1. How does your organisation create acceptance to change?
(Please stress ; training programmes, communication process, strategic planning, performance appraisal process etc.)

C2. In any of your change initiatives, is IT considered to be the main factor that enables change to be carried out? Please explain
(Please stress : IT driven? Business driven?)

C3. In any change initiative, what are the roles of the top management?
(Please stress on: change management, leadership)

C4. In any of your change initiatives, which group of people exerts the most influence in bringing about change please explain
(Please state: IT people, business people?)

C5. Have you noticed any changes in organisational structure and communication process as a result of the introduction of the new information technology?
(This question should be answered only by the company's managers)

Appendix III
SPSS Outputs
Frequencies and Crosstabs

Frequencies

Statistics

	N		Mean	Mode	Min	Max
	Valid	Missing				
Company	41	0				
Department	41	0				
Job title	41	0				
PROJECT	38	3	1.97	1	1	6
networked computers	12	29	261.08	4	4	1000
networked computers department	24	17	15.83	4	0	173
use computers	41	0				
how long use	40	1	7.65	10	0	18
comfortable	41	0	2.20	2	1	6
change the way of working	41	0				
word-processing	41	0				
e-mail	41	0				
presentation	41	0				
CAD/CAM	41	0				
spreadsheet	41	0				
Database	41	0				
Internet	41	0				
job more effective	41	0				
how often do you use computers	41	0	1.68	1	1	5
software	41	0				
EDMS	41	0				
EDMS useful	41	0				
ability to change	40	1	3.23	3	2	5
investment in change	41	0	3.34	3	2	5
training	41	0	3.51	4	2	5
use of IT	41	0	3.44	3	1	5
communication	41	0	3.51	4	2	5
vision	41	0	2.90	3(a)	1	5
senior management commitment	41	0	3.54	3	1	5
leadership and motivation	41	0	4.34	4	1	4
participation	41	0	3.22	4	1	5
team-working	41	0	3.59	4	1	5
training	41	0	2.93	3	1	5
shared perception of problem	41	0	3.05	3	1	5
participative decision-making	41	0	3.02	3	1	5
rewards	41	0	2.83	3	1	5
customer-focused	41	0	3.39	3	1	5
high alignment	41	0	3.32	4	1	5
project planning	41	0	3.56	4	2	5
change occur slowly in the company	41	0	2.41	2	1	4

a Multiple modes exist. The smallest value is shown

Company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Kvaerner	30	73.2	73.2	73.2

	JMBygg	11	26.8	26.8	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	IT	7	17.1	17.1	17.1
	construction	3	7.3	7.3	24.4
	Commercial	3	7.3	7.3	31.7
	Production	14	34.1	34.1	65.9
	Design	4	9.8	9.8	75.6
	planning	4	9.8	9.8	85.4
	Administration	6	14.6	14.6	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Job title

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Application Support Analyst	3	7.3	7.3	7.3
	business systems manager	2	4.9	4.9	12.2
	construction supervisor	5	12.2	12.2	24.4
	commercial manager	2	4.9	4.9	29.3
	contract surveyor	1	2.4	2.4	31.7
	customer service manager	1	2.4	2.4	34.1
	design manager	2	4.9	4.9	39.0
	buyer	1	2.4	2.4	41.5
	production manager	2	4.9	4.9	46.3
	engineer assistant	1	2.4	2.4	48.8
	quality manager	2	4.9	4.9	53.7
	senior project planner	1	2.4	2.4	56.1
	document controller	5	12.2	12.2	68.3
	secretary	2	4.9	4.9	73.2
	planner	4	9.8	9.8	82.9
	engineer	3	7.3	7.3	90.2
	project leader	4	9.8	9.8	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

PROJECT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	22	53.7	57.9	57.9
	2	6	14.6	15.8	73.7
	3	4	9.8	10.5	84.2
	4	2	4.9	5.3	89.5
	5	3	7.3	7.9	97.4
	6	1	2.4	2.6	100.0
	Total	38	92.7	100.0	

Missing	System Missing	3	7.3		
	Total	3	7.3		
Total		41	100.0		

Networked computers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	3	7.3	25.0	25.0
	6	2	4.9	16.7	41.7
	9	1	2.4	8.3	50.0
	10	1	2.4	8.3	58.3
	120	2	4.9	16.7	75.0
	850	1	2.4	8.3	83.3
	1000	2	4.9	16.7	100.0
	Total	12	29.3	100.0	
Missing	System Missing	29	70.7		
	Total	29	70.7		
Total		41	100.0		

Networked computers department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	2.4	4.2	4.2
	1	3	7.3	12.5	16.7
	2	3	7.3	12.5	29.2
	3	2	4.9	8.3	37.5
	4	4	9.8	16.7	54.2
	5	2	4.9	8.3	62.5
	6	3	7.3	12.5	75.0
	8	1	2.4	4.2	79.2
	20	2	4.9	8.3	87.5
	50	2	4.9	8.3	95.8
	173	1	2.4	4.2	100.0
	Total	24	58.5	100.0	
Missing	System Missing	17	41.5		
	Total	17	41.5		
Total		41	100.0		

Use of computers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	40	97.6	97.6	97.6
	no	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

How long use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	months	2	4.9	5.0	5.0
	1	2	4.9	5.0	10.0
	2	2	4.9	5.0	15.0
	3	2	4.9	5.0	20.0
	4	4	9.8	10.0	30.0

	5	2	4.9	5.0	35.0
	6	6	14.6	15.0	50.0
	8	3	7.3	7.5	57.5
	10	9	22.0	22.5	80.0
	12	1	2.4	2.5	82.5
	13	2	4.9	5.0	87.5
	15	3	7.3	7.5	95.0
	17	1	2.4	2.5	97.5
	18	1	2.4	2.5	100.0
	Total	40	97.6	100.0	
Missing	System Missing	1	2.4		
	Total	1	2.4		
Total		41	100.0		

Comfortable and use of computers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	12	29.3	29.3	29.3
	2	15	36.6	36.6	65.9
	3	10	24.4	24.4	90.2
	4	3	7.3	7.3	97.6
	6	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Change the way of working

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	16	39.0	39.0	41.5
	no	24	58.5	58.5	100.0
	1	1	2.4	2.4	2.4
	Total	41	100.0	100.0	
Total		41	100.0		

Word-processing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	36	87.8	87.8	87.8
	no	5	12.2	12.2	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

E-mail

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	27	65.9	65.9	65.9
	no	14	34.1	34.1	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Presentation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	18	43.9	43.9	43.9

	no	23	56.1	56.1	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

CAD/CAM

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	1	2.4	2.4	2.4
	no	40	97.6	97.6	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Spreadsheet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	26	63.4	63.4	63.4
	no	15	36.6	36.6	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Database

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	21	51.2	51.2	51.2
	no	20	48.8	48.8	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Internet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	13	31.7	31.7	31.7
	no	28	68.3	68.3	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Job more effective

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	32	78.0	78.0	80.5
	no	8	19.5	19.5	100.0
		1	2.4	2.4	2.4
	Total	41	100.0	100.0	
Total		41	100.0		

How often do you use computers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	27	65.9	65.9	65.9
	2	5	12.2	12.2	78.0
	3	6	14.6	14.6	92.7
	4	1	2.4	2.4	95.1
	5	2	4.9	4.9	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Software

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	33	80.5	80.5	80.5
	no	8	19.5	19.5	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

EDMS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	19	46.3	46.3	46.3
	no	22	53.7	53.7	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

EDMS useful

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	22	53.7	53.7	100.0
		19	46.3	46.3	46.3
	Total	41	100.0	100.0	
Total		41	100.0		

Ability to change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very satisfactory	7	17.1	17.5	17.5
	Satisfactory	20	48.8	50.0	67.5
	somewhat satisfactory	10	24.4	25.0	92.5
	unsatisfactory	3	7.3	7.5	100.0
	Total	40	97.6	100.0	
Missing	System Missing	1	2.4		
	Total	1	2.4		
Total		41	100.0		

Investment in change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very satisfactory	6	14.6	14.6	14.6
	satisfactory	21	51.2	51.2	65.9
	somewhat satisfactory	8	19.5	19.5	85.4
	unsatisfactory	6	14.6	14.6	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very satisfactory	8	19.5	19.5	19.5
	satisfactory	12	29.3	29.3	48.8
	somewhat satisfactory	13	31.7	31.7	80.5
	unsatisfactory	8	19.5	19.5	100.0

	Total	41	100.0	100.0	
Total		41	100.0		

Use of IT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	excellent	1	2.4	2.4	2.4
	very satisfactory	4	9.8	9.8	12.2
	satisfactory	19	46.3	46.3	58.5
	somewhat satisfactory	10	24.4	24.4	82.9
	unsatisfactory	7	17.1	17.1	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	7.3	7.3	7.3
	3	17	41.5	41.5	48.8
	4	18	43.9	43.9	92.7
	5	3	7.3	7.3	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Vision

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	12.2	12.2	12.2
	2	9	22.0	22.0	34.1
	3	13	31.7	31.7	65.9
	4	13	31.7	31.7	97.6
	5	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Senior management commitment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	4.9	4.9	4.9
	2	3	7.3	7.3	12.2
	3	16	39.0	39.0	51.2
	4	11	26.8	26.8	78.0
	5	9	22.0	22.0	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Leadership and motivation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	9.8	9.8	9.8
	2	4	9.8	9.8	19.5
	3	10	24.4	24.4	43.9

	4	18	43.9	43.9	87.8
	5	4	9.8	9.8	97.6
	44	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Participation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	7.3	7.3	7.3
	2	8	19.5	19.5	26.8
	3	12	29.3	29.3	56.1
	4	13	31.7	31.7	87.8
	5	5	12.2	12.2	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Team-working

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	4.9	4.9	4.9
	2	5	12.2	12.2	17.1
	3	10	24.4	24.4	41.5
	4	15	36.6	36.6	78.0
	5	9	22.0	22.0	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	9.8	9.8	9.8
	2	9	22.0	22.0	31.7
	3	15	36.6	36.6	68.3
	4	12	29.3	29.3	97.6
	5	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Shared perception of problem

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.4	2.4	2.4
	2	8	19.5	19.5	22.0
	3	21	51.2	51.2	73.2
	4	10	24.4	24.4	97.6
	5	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Participative decision-making

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.4	2.4	2.4
	2	10	24.4	24.4	26.8
	3	18	43.9	43.9	70.7
	4	11	26.8	26.8	97.6

	5	1	2.4	2.4	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Rewards

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	14.6	14.6	14.6
	2	9	22.0	22.0	36.6
	3	14	34.1	34.1	70.7
	4	10	24.4	24.4	95.1
	5	2	4.9	4.9	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Customer-focused

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.4	2.4	2.4
	2	6	14.6	14.6	17.1
	3	16	39.0	39.0	56.1
	4	12	29.3	29.3	85.4
	5	6	14.6	14.6	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

High alignment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.4	2.4	2.4
	2	8	19.5	19.5	22.0
	3	11	26.8	26.8	48.8
	4	19	46.3	46.3	95.1
	5	2	4.9	4.9	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

Project planning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	7	17.1	17.1	17.1
	3	10	24.4	24.4	41.5
	4	18	43.9	43.9	85.4
	5	6	14.6	14.6	100.0
	Total	41	100.0	100.0	
Total		41	100.0		

CROSSTABS

Ability to change * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
ability to change	Very satisfactory	Count	5	2	7
		% within ability to change	71.4%	28.6%	100.0%
		% within Company	17.2%	18.2%	17.5%
		% of Total	12.5%	5.0%	17.5%
	Satisfactory	Count	15	5	20
		% within ability to change	75.0%	25.0%	100.0%
		% within Company	51.7%	45.5%	50.0%
		% of Total	37.5%	12.5%	50.0%
	somewhat satisfactory	Count	6	4	10
		% within ability to change	60.0%	40.0%	100.0%
		% within Company	20.7%	36.4%	25.0%
		% of Total	15.0%	10.0%	25.0%
	unsatisfactory	Count	3		3
		% within ability to change	100.0%		100.0%
		% within Company	10.3%		7.5%
		% of Total	7.5%		7.5%
Total		Count	29	11	40
		% within ability to change	72.5%	27,5%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	72.5%	27.5%	100.0%

Investment in change * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
investment in change	very satisfactory	Count	4	2	6
		% within investment in change	66.7%	33.3%	100.0%
		% within Company	13.3%	18.2%	14.6%
		% of Total	9.8%	4.9%	14.6%
	satisfactory	Count	16	5	21
		% within investment in change	76.2%	23.8%	100.0%
		% within Company	53.3%	45.5%	51.2%
		% of Total	39.0%	12.2%	51.2%

	somewhat satisfactory	Count	5	3	8
		% within investment in change	62.5%	37.5%	100.0%
		% within Company	16.7%	27.3%	19.5%
		% of Total	12.2%	7.3%	19.5%
	unsatisfactory	Count	5	1	6
		% within investment in change	83.3%	16.7%	100.0%
		% within Company	16.7%	9.1%	14.6%
		% of Total	12.2%	2.4%	14.6%
Total		Count	30	11	41
		% within investment in change	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Training * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
training	very satisfactory	Count	5	3	8
		% within training	62.5%	37.5%	100.0%
		% within Company	16.7%	27.3%	19.5%
		% of Total	12.2%	7.3%	19.5%
	satisfactory	Count	8	4	12
		% within training	66.7%	33.3%	100.0%
		% within Company	26.7%	36.4%	29.3%
		% of Total	19.5%	9.8%	29.3%
	somewhat satisfactory	Count	10	3	13
		% within training	76.9%	23.1%	100.0%
		% within Company	33.3%	27.3%	31.7%
		% of Total	24.4%	7.3%	31.7%
	unsatisfactory	Count	7	1	8
		% within training	87.5%	12.5%	100.0%
		% within Company	23.3%	9.1%	19.5%
		% of Total	17.1%	2.4%	19.5%
Total		Count	30	11	41
		% within training	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Use of IT * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
use of IT	excellent	Count	1		1

		% within use of IT	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
	very satisfactory	Count	3	1	4
		% within use of IT	75.0%	25.0%	100.0%
		% within Company	10.0%	9.1%	9.8%
		% of Total	7.3%	2.4%	9.8%
	satisfactory	Count	12	7	19
		% within use of IT	63.2%	36.8%	100.0%
		% within Company	40.0%	63.6%	46.3%
		% of Total	29.3%	17.1%	46.3%
	somewhat satisfactory	Count	8	2	10
		% within use of IT	80.0%	20.0%	100.0%
		% within Company	26.7%	18.2%	24.4%
		% of Total	19.5%	4.9%	24.4%
	unsatisfactory	Count	6	1	7
		% within use of IT	85.7%	14.3%	100.0%
		% within Company	20.0%	9.1%	17.1%
		% of Total	14.6%	2.4%	17.1%
Total		Count	30	11	41
		% within use of IT	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Communication * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
communication	2	Count	3		3
		% within communication	100.0%		100.0%
		% within Company	10.0%		7.3%
		% of Total	7.3%		7.3%
	3	Count	12	5	17
		% within communication	70.6%	29.4%	100.0%
		% within Company	40.0%	45.5%	41.5%
		% of Total	29.3%	12.2%	41.5%
	4	Count	13	5	18
		% within communication	72.2%	27.8%	100.0%
		% within Company	43.3%	45.5%	43.9%
		% of Total	31.7%	12.2%	43.9%
	5	Count	2	1	3
		% within communication	66.7%	33.3%	100.0%
		% within Company	6.7%	9.1%	7.3%
		% of Total	4.9%	2.4%	7.3%
Total		Count	30	11	41

	% within communication	73.2%	26.8%	100.0%
	% within Company	100.0%	100.0%	100.0%
	% of Total	73.2%	26.8%	100.0%

Vision * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
vision	1	Count	5		5
		% within vision	100.0%		100.0%
		% within Company	16.7%		12.2%
		% of Total	12.2%		12.2%
	2	Count	7	2	9
		% within vision	77.8%	22.2%	100.0%
		% within Company	23.3%	18.2%	22.0%
		% of Total	17.1%	4.9%	22.0%
	3	Count	8	5	13
		% within vision	61.5%	38.5%	100.0%
		% within Company	26.7%	45.5%	31.7%
		% of Total	19.5%	12.2%	31.7%
	4	Count	9	4	13
		% within vision	69.2%	30.8%	100.0%
		% within Company	30.0%	36.4%	31.7%
		% of Total	22.0%	9.8%	31.7%
	5	Count	1		1
		% within vision	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
Total		Count	30	11	41
		% within vision	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Senior management commitment * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
senior management commitment	1	Count	2		2
		% within senior management commitment	100.0%		100.0%
		% within Company	6.7%		4.9%
		% of Total	4.9%		4.9%
	2	Count	3		3
		% within senior management commitment	100.0%		100.0%
		% within Company	10.0%		7.3%

		% of Total	7.3%		7.3%
	3	Count	8	8	16
		% within senior management commitment	50.0%	50.0%	100.0%
		% within Company	26.7%	72.7%	39.0%
		% of Total	19.5%	19.5%	39.0%
	4	Count	8	3	11
		% within senior management commitment	72.7%	27.3%	100.0%
		% within Company	26.7%	27.3%	26.8%
		% of Total	19.5%	7.3%	26.8%
	5	Count	9		9
		% within senior management commitment	100.0%		100.0%
		% within Company	30.0%		22.0%
		% of Total	22.0%		22.0%
Total		Count	30	11	41
		% within senior management commitment	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Leadership and motivation * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
leadership and motivation	1	Count	4		4
		% within leadership and motivation	100.0%		100.0%
		% within Company	13.3%		9.8%
		% of Total	9.8%		9.8%
	2	Count	4		4
		% within leadership and motivation	100.0%		100.0%
		% within Company	13.3%		9.8%
		% of Total	9.8%		9.8%
	3	Count	8	2	10
		% within leadership and motivation	80.0%	20.0%	100.0%
		% within Company	26.7%	18.2%	24.4%
		% of Total	19.5%	4.9%	24.4%
	4	Count	9	9	18
		% within leadership and motivation	50.0%	50.0%	100.0%
		% within Company	30.0%	81.8%	43.9%
		% of Total	22.0%	22.0%	43.9%
	5	Count	4		4

		% within leadership and motivation	100.0%		100.0%
		% within Company	13.3%		9.8%
		% of Total	9.8%		9.8%
	44	Count	1		1
		% within leadership and motivation	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
Total		Count	30	11	41
		% within leadership and motivation	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Participation * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
Participation	1	Count	3		3
		% within participation	100.0%		100.0%
		% within Company	10.0%		7.3%
		% of Total	7.3%		7.3%
	2	Count	7	1	8
		% within participation	87.5%	12.5%	100.0%
		% within Company	23.3%	9.1%	19.5%
		% of Total	17.1%	2.4%	19.5%
	3	Count	9	3	12
		% within participation	75.0%	25.0%	100.0%
		% within Company	30.0%	27.3%	29.3%
		% of Total	22.0%	7.3%	29.3%
	4	Count	7	6	13
		% within participation	53.8%	46.2%	100.0%
		% within Company	23.3%	54.5%	31.7%
		% of Total	17.1%	14.6%	31.7%
	5	Count	4	1	5
		% within participation	80.0%	20.0%	100.0%
		% within Company	13.3%	9.1%	12.2%
		% of Total	9.8%	2.4%	12.2%
Total		Count	30	11	41
		% within participation	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Team-working * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
Team-working	1	Count	2		2
		% within team-working	100.0%		100.0%

		% within Company	6.7%		4.9%
		% of Total	4.9%		4.9%
	2	Count	5		5
		% within team-working	100.0%		100.0%
		% within Company	16.7%		12.2%
		% of Total	12.2%		12.2%
	3	Count	8	2	10
		% within team-working	80.0%	20.0%	100.0%
		% within Company	26.7%	18.2%	24.4%
		% of Total	19.5%	4.9%	24.4%
	4	Count	9	6	15
		% within team-working	60.0%	40.0%	100.0%
		% within Company	30.0%	54.5%	36.6%
		% of Total	22.0%	14.6%	36.6%
	5	Count	6	3	9
		% within team-working	66.7%	33.3%	100.0%
		% within Company	20.0%	27.3%	22.0%
		% of Total	14.6%	7.3%	22.0%
Total		Count	30	11	41
		% within team-working	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Training * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
training	1	Count	3	1	4
		% within training	75.0%	25.0%	100.0%
		% within Company	10.0%	9.1%	9.8%
		% of Total	7.3%	2.4%	9.8%
	2	Count	7	2	9
		% within training	77.8%	22.2%	100.0%
		% within Company	23.3%	18.2%	22.0%
		% of Total	17.1%	4.9%	22.0%
	3	Count	9	6	15
		% within training	60.0%	40.0%	100.0%
		% within Company	30.0%	54.5%	36.6%
		% of Total	22.0%	14.6%	36.6%
	4	Count	10	2	12
		% within training	83.3%	16.7%	100.0%
		% within Company	33.3%	18.2%	29.3%
		% of Total	24.4%	4.9%	29.3%
	5	Count	1		1
		% within training	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
Total		Count	30	11	41
		% within training	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Shared perception of problem * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
shared perception of problem	1	Count	1		1
		% within shared perception of problem	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
	2	Count	8		8
		% within shared perception of problem	100.0%		100.0%
		% within Company	26.7%		19.5%
		% of Total	19.5%		19.5%
	3	Count	13	8	21
		% within shared perception of problem	61.9%	38.1%	100.0%
		% within Company	43.3%	72.7%	51.2%
		% of Total	31.7%	19.5%	51.2%
	4	Count	7	3	10
		% within shared perception of problem	70.0%	30.0%	100.0%
		% within Company	23.3%	27.3%	24.4%
		% of Total	17.1%	7.3%	24.4%
	5	Count	1		1
		% within shared perception of problem	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
Total		Count	30	11	41
		% within shared perception of problem	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Participative decision-making * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
participative decision-making	1	Count	1		1
		% within participative decision-making	100.0%		100.0%
		% within Company	3.3%		2.4%

		% of Total	2.4%		2.4%
	2	Count	10		10
		% within participative decision-making	100.0%		100.0%
		% within Company	33.3%		24.4%
		% of Total	24.4%		24.4%
	3	Count	10	8	18
		% within participative decision-making	55.6%	44.4%	100.0%
		% within Company	33.3%	72.7%	43.9%
		% of Total	24.4%	19.5%	43.9%
	4	Count	8	3	11
		% within participative decision-making	72.7%	27.3%	100.0%
		% within Company	26.7%	27.3%	26.8%
		% of Total	19.5%	7.3%	26.8%
	5	Count	1		1
		% within participative decision-making	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
Total		Count	30	11	41
		% within participative decision-making	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Rewards * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
rewards	1	Count	6		6
		% within rewards	100.0%		100.0%
		% within Company	20.0%		14.6%
		% of Total	14.6%		14.6%
	2	Count	8	1	9
		% within rewards	88.9%	11.1%	100.0%
		% within Company	26.7%	9.1%	22.0%
		% of Total	19.5%	2.4%	22.0%
	3	Count	7	7	14
		% within rewards	50.0%	50.0%	100.0%
		% within Company	23.3%	63.6%	34.1%
		% of Total	17.1%	17.1%	34.1%
	4	Count	7	3	10
		% within rewards	70.0%	30.0%	100.0%
		% within Company	23.3%	27.3%	24.4%
		% of Total	17.1%	7.3%	24.4%
	5	Count	2		2

		% within rewards	100.0%		100.0%
		% within Company	6.7%		4.9%
		% of Total	4.9%		4.9%
Total		Count	30	11	41
		% within rewards	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Customer-focused * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
customer-focused	1	Count	1		1
		% within customer-focused	100.0%		100.0%
		% within Company	3.3%		2.4%
		% of Total	2.4%		2.4%
	2	Count	5	1	6
		% within customer-focused	83.3%	16.7%	100.0%
		% within Company	16.7%	9.1%	14.6%
		% of Total	12.2%	2.4%	14.6%
	3	Count	12	4	16
		% within customer-focused	75.0%	25.0%	100.0%
		% within Company	40.0%	36.4%	39.0%
		% of Total	29.3%	9.8%	39.0%
	4	Count	7	5	12
		% within customer-focused	58.3%	41.7%	100.0%
		% within Company	23.3%	45.5%	29.3%
		% of Total	17.1%	12.2%	29.3%
	5	Count	5	1	6
		% within customer-focused	83.3%	16.7%	100.0%
		% within Company	16.7%	9.1%	14.6%
		% of Total	12.2%	2.4%	14.6%
Total		Count	30	11	41
		% within customer-focused	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

High alignment * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
high alignment	1	Count	1		1
		% within high alignment	100.0%		100.0%
		% within Company	3.3%		2.4%

		% of Total	2.4%		2.4%
	2	Count	7	1	8
		% within high alignment	87.5%	12.5%	100.0%
		% within Company	23.3%	9.1%	19.5%
		% of Total	17.1%	2.4%	19.5%
	3	Count	11		11
		% within high alignment	100.0%		100.0%
		% within Company	36.7%		26.8%
		% of Total	26.8%		26.8%
	4	Count	10	9	19
		% within high alignment	52.6%	47.4%	100.0%
		% within Company	33.3%	81.8%	46.3%
		% of Total	24.4%	22.0%	46.3%
	5	Count	1	1	2
		% within high alignment	50.0%	50.0%	100.0%
		% within Company	3.3%	9.1%	4.9%
		% of Total	2.4%	2.4%	4.9%
Total		Count	30	11	41
		% within high alignment	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%

Project planning * Company Crosstabulation

			Company		Total
			Kvaerner Construction	JMBygg	
project planning	2	Count	7		7
		% within project planning	100.0%		100.0%
		% within Company	23.3%		17.1%
		% of Total	17.1%		17.1%
	3	Count	9	1	10
		% within project planning	90.0%	10.0%	100.0%
		% within Company	30.0%	9.1%	24.4%
		% of Total	22.0%	2.4%	24.4%
	4	Count	11	7	18
		% within project planning	61.1%	38.9%	100.0%
		% within Company	36.7%	63.6%	43.9%
		% of Total	26.8%	17.1%	43.9%
	5	Count	3	3	6
		% within project planning	50.0%	50.0%	100.0%
		% within Company	10.0%	27.3%	14.6%
		% of Total	7.3%	7.3%	14.6%
Total		Count	30	11	41
		% within project planning	73.2%	26.8%	100.0%
		% within Company	100.0%	100.0%	100.0%
		% of Total	73.2%	26.8%	100.0%