THE DESIGN AND IMPLEMENTATION OF
PRODUCT DEVELOPMENT PROCESS MODELS
IN CONSTRUCTION COMPANIES

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Declaration

I declare that the research contained in this thesis was solely carried out by me. This thesis has not been previously submitted to this or any other institution for an award of a degree or any other qualification.
Abstract

The need for improving the product development process within the construction industry is widely acknowledged. In response to this challenge, different process models have been developed by academia and industry to enhance the effectiveness and efficiency of the design and construction activity. However, the effective and widespread adoption and use of product development process models in practice has been limited, and the benefits resulting from these endeavours have been ambiguous at best and non-existent at worst. This led to the research need for better understanding of the dynamics of implementing product development process models in construction firms. Such understanding includes identifying strategies to allow the process model adaptation and adoption into specific project environments, as well as examining factors that affect implementation. To develop such understanding the process management, organisational change and technology transfer literature have been revised and synthesised.

The research methodology employed a case study approach to test research hypotheses and, in doing so, create new theoretical insights. Different research techniques were applied, including literature review and synthesis, interviews, observation, content analysis and cognitive mapping. As a result, a better understanding of implementation in real life settings was achieved through a detailed discussion of implementation cases. This research has produced a theoretical framework to evaluate the content of product development process models with a view to its implementation and a typology for factors affecting implementation. The key research findings are: the need to consider the design and implementation of process models in an integrated fashion within the organisational context in which it takes place; and, a shift in the role of product development process models within firms from a rational ‘planning and control perspective’ to a softer ‘learning’ approach.
1 Introduction

1.1 Introduction

This chapter provides an introduction to the research presented in this thesis. It addresses the importance of the product development process (PDP) in construction. The need for the construction industry to improve its performance has stimulated policymakers and industrialists to look at other industries for ideas and motivation (Gann, 1996; Brookes et al., 1999; Winch, 2003). The advances in product development in manufacturing have prompted the construction industry to initiate a number of initiatives aiming at designing and implementing process models as a means to achieve process improvement (for example, Kagioglou et al., 1998). The low success rates reported on the adoption and use of process models in practice (for example, Hammer and Champy, 2001) brings into sharp and immediate focus the need for better understanding of the dynamics of product development process models’ implementation in construction firms.

This chapter presents the rational for this research, the research aim and objectives, and an outline of the research method employed. The thesis structure is presented to inform the reader about the overall direction and content of this thesis.

1.2 Background to the research

The problems of the construction industry are well known. Construction productivity lags behind that of manufacturing, and the quality of construction in general is considered to be poor (Koskela, 2000). Numerous government and institutional reports, for example Egan (1998), DTI (2002), and Fairclough (2002), have examined various aspects of design and construction, and consistently promoted the need for innovation and change in process management practices. The complexity of design and construction has been constantly noted as the primary reason for the difficulty in sustaining significant improvements in this area (Aouad et al., 1994).

Process management practices in construction have been focused on both design process management (the focal point being managing the production of information) and on construction management (with a focus on managing the physical production of
a facility). In this research, a broader perspective is adopted to design management, borrowing the concept of the product development process from manufacturing\(^1\). This concept refers mainly to the initial stages of a project, aiming at making explicit the importance of considering not only design, but also the interfaces between the design process and other processes that occur in the preliminary phases of construction. Investment on high quality product development by an integrated team has been pointed out as crucial to the success of any construction project, since it is at the outset that the significant majority of value can be created and sustained (DTI, 2002).

Product development has been defined as the process through which a product is conceived, designed and launched in the market, and includes the feedback from both production and product use (Ulrich and Eppinger, 2000). It includes both product and production process design activities, as these tasks need to be performed together. Although most of them consist of design work, there are other kinds of activities involved, such as financial evaluations and customer surveys. Product development begins with the perception of a market opportunity and typically involves the capture and management of customer requirements, concept development, product design, market launching, and collection and dissemination of feedback data (Cooper, 1998; Yazdani and Holmes, 1999).

Due to the importance of product development, a number of studies have been undertaken focusing on how effective and efficient product development projects have been carried out in various industries. Different disciplines have focused significant attention on product development; including, for example, marketing and strategy, management, economics, sociology, engineering, and operations management (Maylor, 1997). Engineering researchers have typically focused on formal structures involved in engineering design decisions, while management research has concentrated on the myriad organisational issues involved in product development. Nevertheless, this diversity of approaches has been leading to the fragmentation of research efforts and to the portrayal that there is a lack of a theoretical foundation for product development management (Shu, 1990, Koskela, 2000).

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\(^1\) See section 2.2.2 for a discussion on the definition of ‘product development process’ both in manufacturing and construction.
In recent years, the increasing complexity of modern buildings and the growing competition in the market has significantly increased the pressure for improving the performance of product development in the construction industry. The industry needs to provide greater value to its clients through its products (Egan et al., 1998), as many projects are often not delivered within the expected budget and time and are poorly focused on client needs. Clients of constructed facilities are demanding delivered projects in greatly reduced timeframes and placing increasingly rigorous demands in terms of cost and quality (Koskela, 2000).

Product development poses difficult managerial problems, which are similar in manufacturing and construction. Even products of modest complexity require thousands of interdependent decisions. There are often conflicting requirements, demanding an effort to recognise and understand trade-offs, and decision making is usually carried out without complete information (Reinertsen, 1997; Sanban et al., 2000; Herder et al., 2003; Koskela, 2004). A large number of stakeholders are involved in product development, and each professional category has a different background, culture, language and learning style (Reinertsen, 1995; Ulrich and Eppinger, 2000). Therefore, poor communications, lack of adequate documentation, deficient or missing input information, unbalanced resource allocation, lack of coordination between disciplines and erratic decision-making have been pointed out as major problems (Cornick, 1991; Austin et al., 1994; Ballard and Koskela, 1998).

It has been proposed that the means to navigate through, and reduce, product development complexity is through the design and implementation of appropriate generic process models, which would allow for consistent and integrated processes (Cooper, 1994; Kagioglou et al., 1998; Which and Carr, 2001). As a result, much effort has been spent in devising models for the product development process, most of it in the manufacturing industry. The scope, objective, and conceptual basis of those models vary widely (Formoso et al., 2002). Descriptive models simply try to depict parts of the process (for example, the design process is described by Hales, 1993), or the whole product development process (for instance, Yazdani and Holmes, 1999). There are also prescriptive models that attempt to provide protocols and tools to support improved product development management (e.g. Ulrich and Eppinger, 2000). Such models are supposed to be used as templates that contain a generic process model and a set of techniques and tools to support different tasks.
In the construction industry, there has also been considerable interest in developing generic process models or protocols (e.g. Kagioglou et al., 2000; Tunstall, 2000; Gray and Hughes, 2001), which were developed as a response to the challenges the industry faces in terms of being able to deliver projects that are predictable on cost, time and quality, through an understanding of customer requirements (Egan, 1998; DTI, 2002).

Process mapping is becoming increasingly accepted because it is recognised that even though relationships are complex and dynamic in a project environment, the underlying generic processes remains broadly consistent (Mill and Ion, 1994; Kagioglou, et al., 1998). Initiatives aiming at establishing process models both at the whole project level and at the operational level in the construction industry have tried to transfer established manufacturing principles at both levels (Kagioglou, 1999; Winch, 2002). Therefore, it has been proposed that the potential benefits addressed in manufacturing of designing and using process models could also be achieved in the construction context.

However, the effective adoption and use of process models in practice has been fairly slow, and there have been ambiguous signs of improvement resulting from these solutions (Austin et al., 2000). Hammer and Champy (2001), for instance, identified that implementation of new or redesigned processes fail in 50 to 70% of Business Process Reengineering (BPR) initiatives. The success rate of new process implementation in construction is unclear due to a lack of empirical research –this constitutes a research need in itself. Nevertheless, anecdotal evidence indicates that the success rates are not good - for example, process models’ implementation difficulties in construction were the focus of the Process Network2 workshop, held in November 2001.

There are several reasons cited for the high failure rates of re-engineering. Cao et al. (2001), for example, argue that the focus of reengineering is too narrow: major barriers to implementation exist due to the inadequate attention to human issues related to resisting change. Smith and Morrow (1999) analysed product development process modelling efforts in manufacturing and concluded that most models presented in the literature are not applicable to projects. Finally, Lawson et al. (2003) state that model failure often occurs because of the lack of motivation: many process maps are left

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2 Information on the Process Network, a network on process knowledge funded by the EPSRC, can be found on the web page: http://www.processnetwork.org.uk
unused on the shelf regardless of the time, knowledge and effort invested in developing them.

It is here argued that there is an apparent lack of consideration of implementation in process modelling research. Even though the main aim of modelling is the effective use of the model in real life settings, studies on processes tend to focus on the design of the process model, rather than describing their implementation (for example, Austin et al., 2001; RIBA, 2002). Some studies found in the process management literature superficially address implementation issues, but the implementation process is not comprehensively analysed or described (for example, Cooper, 2001; Kagioglou et al., 1998). Therefore, it can be argued that there is a significant gap in the literature on process model implementation.

The espoused benefits from generic product development process models can only be accomplished through the effective use of these models in real product development settings. The departing point for this research is an assertion that there is a mismatch between the espoused benefits of generic product development process models and the actual benefits realised in practice. The aim is to understand this mismatch from the proposition that the espoused benefits are not accomplished because of inadequate consideration of implementation of generic product development process models.

In summary, it is argued that much effort has been put into developing product development process models in manufacturing and construction. However, little effort has been directed into understanding the process of implementing such processes, i.e. means for adapting product development process models within organisational and project contexts. Further, the factors that can affect the effectiveness of the use of process models throughout the organisation have not been appropriately described in the literature. This leads to a research need for exploring the implementation of product development process models within construction firms, including strategies to allow the process model adaptation and adoption into specific project environments, as well as examining the factors that affect implementation in both positive and negative ways.
1.2.1 Choice of research focus

The choice of the research focus was based on current trends and arguments in the literature and the author’s previous experiences with process management. The author’s previous experience involved the development of a design management process model for construction organisations through action research (Tzortzopoulos, 1999). As an outcome of this study, the conclusion was made that construction companies would invest great amount of time and effort to design processes, and would achieve fairly complex models as an outcome, but such companies demonstrated great difficulties in effectively implementing them. This happened even though the models were developed internally, involving all the major process stakeholders, aligned with the business strategy of the company and focused on the improvements needed at the organisational level. The author herself worked at one of the companies as a design manager for three years and realised the difficulties involved in implementing process models from within the company.

In addition, the process models implementation failure rates presented in the BPR literature, and the apparent lack of consideration of implementation in process modelling research further suggested that implementation difficulties are an issue faced by a large number of companies that try to adopt process models. Therefore, the need to understand the difficulties that occur in practice and how implementation success rates could be improved can be justified. Hence, this demonstrates the importance of further investigating process models implementation and the role of process models as means to improve product development management.

The investigation focuses on the design and use of product development process models by construction contractors. The rationale for this focus is due to the current trend for UK contractors being more involved with design issues, due to an increasing number of design and build and PFI (Private Finance Initiative) type of contracts. As a consequence, contractors need to increase their capacity and capability in terms of design in order to create value added for clients. More importantly, the construction industry needs to be able to adopt an integrated approach to design and construction, and it is believed that greater contractors’ involvement in front-end design activities will make a significant contribution to this goal.
1.3 **Research aim and objectives**

1.3.1 **Research aim**

The overall aim of this research is to improve the understanding of product development process models implementation in construction companies. It aims to propose recommendations that can increase the effectiveness of future product development process model implementations. It endeavours to explore implementation in practice and, through that, reveal the reasons why the espoused benefits of process models are difficult to accomplish. In doing so, the lessons learnt can improve the performance of the product development process in the construction industry.

1.3.2 **Research objectives**

To satisfy the research aim, the following research objectives were established:

- investigate current process model implementation scenarios in construction and manufacturing firms and identify business drivers for the use of process models as well as the main outcomes achieved;
- understand the role of process models as the initial point for managing product development;
- propose appropriate means to evaluate the content of process models (as the object to be implemented) with a view to their successful implementation; and
- explore and prioritise factors that drive, enable, and restrain successful implementation of product development process models.

1.3.3 **Novel contributions**

The starting point of a research effort should focus on the fact that the ultimate purpose of research is to add or challenge the body of accumulated knowledge (Remenyi et al., 1998) and, in doing so, add value through novel contributions. The novel contribution of this research is presented in terms of a better understanding of the implementation of process models in real life settings. This better understanding aims at addressing the gap identified in the literature between a process model design and its use, and to understand the mismatch between the espoused benefits and the actual benefits realised in practice.
Initially, the thesis presents a novel contribution by reviewing and synthesising three, often disparate bodies of knowledge in an integrated manner: process management, organisational change and knowledge (or technology) transfer. Therefore, it examines implementation using different and complementary theoretical lenses. Implementation is thus analysed from the perspective of the managerial improvements in relation to the current product development process (PDP) in practice, drawing from process management research. It is also analysed from the viewpoint of introducing change, due to the fact that the use of a new process model implies changes at the organisational, project and individual levels. Finally, implementation is approached in terms of the transfer of the knowledge embedded in the product development process model from the model designers to its users.

The literature review also focuses on process management on both manufacturing and construction, so that it is possible to discuss the main drivers for designing process models and the main espoused benefits of their application in practice. It was necessary to look into manufacturing as most process management principles adopted in construction have originated from the manufacturing industry (see, for instance Brookes et al., 1999; Kagioglou, 1999).

The novelty of the research results can be derived from four main activities: (a) the structured analysis of implementation in practice in four cases by describing in detail the implementation triggers, outcomes, process and content, which have brought light into the different reasons why implementation has been unsuccessful in construction companies; (b) the understanding of the role of process models within companies, and how they can contribute to product development management; (c) the development and testing of a novel framework to evaluate product development process model content in specific company contexts with a view to its implementation; and, (d) the structured presentation and discussion of the factors that drive and enable implementation, as well as implementation difficulties.

1.4 Methodological approach

The outline of the research method is presented in Figure 1.1, which shows a summarised graphical representation of the main activities undertaken.
The study was divided into four phases, developed in interaction and with a number of feedback loops (represented by the arrows in Figure 1.1): (a) preliminary design and definition; (b) exploratory cases; (c) main case study; and, (d) overall evaluation and conclusions. In the first phase, a review of the literature was conducted to identify the area of concern, research gaps and preliminary questions. This review included the areas of design management, process management, lean production/construction, and new product development. This was a fundamental step to narrow the scope and aims of the study. A structured first proposal was then developed, including the definition of objectives, the unit of analysis, and design of appropriate data collection and analysis described through case study protocols.

![Figure 1.1: Outline research methodology](image)

Having identified the main research focus, exploratory cases within two construction and one manufacturing firms were developed to increase the researcher’s understanding of the area, clarifying some major issues surrounding the implementation of product development process models. This has broadened the understanding of the research issues, in turn, generated the need to extend the literature review to the areas of change management and technology transfer, resulting in a revision of the overall research proposal.
The main case study was then conducted within a construction firm to provide for detailed information on the triggers, process, content and outcomes of implementation. The information collected through both exploratory and main case studies was then (re)analysed, and conclusions drawn.

The detailed research method, described in chapter 3, provides a comprehensive description and justification for the methodological choices made by the researcher, describing the underlying research philosophy, approach and techniques applied. The decision to concentrate on one main case study was made in order to provide for a large amount of rich information about an on-going implementation. The choice of the company fitted the requirements of the research, and the timing of implementation provided the researcher with rich information on the process model design as well as its implementation.

### 1.5 Thesis structure

This thesis is organised around six chapters, which are summarised as follows.

The first chapter presents a general introduction, outlining the research problem, the need for the research, its aims and objectives, relevance and contributions. It also provides an outline of the research methodology employed.

Chapter two presents the literature review and synthesis, concentrating on relevant literature in the research areas being investigated. Gaps in the understanding of implementation were identified, and a multi conceptual perspective on implementation is presented. This contributed to the development of the research questions and hypotheses, also presented in chapter two.

Chapter three describes the design, development and execution of the research methodology applied in this research. The chapter describes the research methodology, research philosophy, strategy, the techniques applied and the validation aspects of the methodology.

Chapter four focuses on the single case analysis, presenting in detail the evidence collected during this research in case studies A, B and C. The chapter also presents the
refinement and application of the framework to evaluate PDP model content with a view to implementation, as well as a typology to classify the factors affecting implementation.

Chapter five describes the single case analysis for Company D, which was the main case study developed as part of this research.

Chapter six concentrates on the cross case analysis, presenting the evidence used to test research hypotheses, and thus generate new theoretical insights.

Finally, chapter seven examines the achievement of the aim and objectives of the research, presenting conclusions about the research hypothesis, recommendations for future PDP model design and implementation in this way, the research work is summarised.

Appendices provide additional detailed information related to the research, which is presented separately as their inclusion on the main text of the thesis would have disrupted the flow of the argument.

### 1.6 Summary

This chapter presented an introduction to the research presented in this thesis. The research problem and objectives were discussed. The gap that exists between product development process model design and its implementation was identified. This led to the identification of a research need to better understand implementation of process models within construction companies. The originality and importance of the research was presented, as well as an outline of the methodology employed throughout the research process. Finally, the thesis structure was presented.

The next chapter presents a review and synthesis of the relevant literature, providing the theoretical background of this research.
2 Literature review and synthesis

2.1 Introduction

Chapter 1 set out the research problem and its justification. Chapter 2 concentrates on presenting relevant literature on the research areas being investigated, which contributes to the development of the research hypotheses. Gaps in the understanding of implementation have been identified through a synthesis of the literature in the field, and from this synthesis a multi conceptual, broader perspective on implementation has been developed. The conceptual model aims to provide a broad picture of the current knowledge of implementation, as shown in Figure 2.1. Evidence supporting the validity of this model is presented throughout this chapter.

Figure 2.1: Implementation concept model

Figure 2.1 suggests that successful implementation outcomes (i.e. the effective adoption and use of a process model within a construction firm) can be achieved through suitable implementation triggers (related to the improvement need), and will be determined by an appropriate implementation process (i.e. the strategy and steps adopted, and the way the model content is transferred to its users) as well as by the usefulness of the process model content itself.

Therefore, different bodies of knowledge were analysed aiming to reach a holistic understanding about the implementation of PDP models in construction. This chapter is
organised around three main issues: (a) the implementation triggers and outcomes, drawing from process management literature; it discusses why implementation is needed, what it seeks for, which are the main improvement principles involved and the reported outcomes of implementation; (b) insights into the implementation process, approaching organisational change as conceptual lenses to understand implementation steps; and (c) insights into the implementation process as the transfer of the knowledge embedded in a process model, drawing from the knowledge transfer literature.

### 2.2 Implementation triggers and outcomes

Implementation triggers relates to the reasons why a company decides to invest time and effort to design and implement PDP models. Outcomes relate to the benefits that will accrue from the initiative. Therefore, triggers and outcomes are closely related, and are described in this section. However, prior to that, it is necessary to define the term process in the context of this research. Processes exist in organisations with different levels of detail and use, and are expressed using different terminology (Cooper, 1994; Kagioglou, 1999; Ballard, 2000). The next section presents the definition of process here adopted, and discusses developments achieved in process management literature.

#### 2.2.1 Process defined

Processes have been the focus of studies in different areas such as new product development (NPD), business process reengineering (BPR) and operations management for many years. Due to this diversity, different definitions of processes can be found in the literature (Lindsay et al., 2003). This section presents two complementary views on process. The first emerged through the framework of scientific management, and describes processes as transformations of inputs into outputs. The second proposes that processes are composed not only by transformations, but also by flows and value generation. These are presented subsequently, with a focus on design and product development. Following that, the concept adopted in the research is discussed.

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1 In this research the terms knowledge transfer and technology transfer are considered as synonymous.

4 The terms design and product development are used in this research in an interchangeable manner. The concept of product development is presented in section 2.2.2.
Scientific management approach

The rationale for the concept of process comes from the framework of scientific management in approaching the task, as described by Taylor (1913). Preparing and carrying out tasks were considered as the basis of scientific management (Voss, 1995). The idea of task was important since proper execution of work was considered to include planning it completely before starting. Along these lines, defining tasks was necessary to make all pre-requisites ready, and to ensure that the most efficient method was followed (Koskela, 2000). A definition of production\footnote{The term production has been used in the literature both in its narrow (production proper) and broad meanings (product development, order-delivery and production). In this research, product development is analysed as a production processes, and therefore the broad meaning of production is approached.} compatible with the idea of ‘task’ was the transformation of production factors (inputs) into products (outputs). Slack et al. (2001:9-10) state:

“all operations produce goods or services by devising processes which transform or change the state or condition of something to produce outputs … processes take in a set of input resources which are then used to transform something, or are transformed themselves, into outputs of goods or services which satisfies customer needs. All operations conform to this general input-transformation-output model”

This concept has been widely used within the literature. For instance, Harrington (1991:9) refers to a process as “any activity or group of activities that takes an input, adds value to it and provides an output to an external customer”, while Davenport (1993:5) states that “a process is simply a structured, measured set of activities designed to produce a specified output for a particular customer or market”. The transformation concept of process is represented in Figure 2.2.

![Figure 2.2: Process as a transformation](image)

Processes can be broken up into smaller, more manageable parts. The whole process can be decomposed into sub-processes, which are smaller versions of the whole operations of which they form a part (Slack et al., 2001). This is a potentially powerful idea, since the same set of managerial principles can be used at different levels, which simplifies...
management (Koskela, 2000). From this hierarchical decomposition, different process levels can be defined, as represented in Figure 2.3.

Huovila et al. (1997) illustrate the different process levels in the following way. The first level could be the whole PDP, which transforms client needs and requirements into the design and specifications of a product. The second level consists of sub-processes such as conceptual design and detail design, and the outputs of conceptual design are the inputs of detail design. An example of the third level, activity, can be the development of the design brief. The fourth level consists of separate tasks such as meeting with clients, or analysing site information. In reality, a process could be decomposed into as many hierarchical levels as required, and there is no exact definition of how this decomposition should be done, i.e. which criteria should be used to do it.

Processes exist within and between organisations, and different types of processes can be found within organisations. Peppard and Rowland (1995) proposed three types: (a) strategic: processes in which the organisation plans for and develops its future; (b) operational: processes by which the organisation carries out its daily functions; and (c) enabling: those that enable strategic and operational processes to be carried out. Other sub-categories of processes could be proposed, e.g. strategic at the organisational level or strategic at the business unit level. Communications and information technology (IT) could be enabling processes for contractors, but strategic for a design consultancy. Therefore, the definitions apply accordingly to the specific environment for which they are formulated.
Transformation, flow and value generation view on processes

The conceptualisation of processes as transformations, flows and value generation (TFV) is described as follows, based on the theory proposed by Koskela (2000). This author originally presented such conceptualisation (Koskela, 1992), and his thinking has influenced many developments in the area (see, for instance, Love et al., 1999; Green, 1999; Ballard, 2000; Dubois and Gadde, 2002). The main argument of the TFV theory is that production processes, such as product development or the physical production of a constructed artefact, need to be analysed not only as transformations but also as flows and as value generation.

The flow view describes processes as being composed by transformations, but also by waiting, inspection and moving of information or materials, as shown in Figure 2.4.

![Figure 2.4: Flow concept](image)

In this conceptualisation, waiting, moving and inspection of information or materials are non-value adding activities and should be eliminated, if possible, or made more efficient (Koskela, 2000). Parts of the transformations are also non-value adding, since they cause rework, due to errors, omissions and uncertainty (Huovila et al., 1997). As a result, improvements involve minimizing the share of non-transformation stages of production, which are regarded as waste.

Processes are further viewed as means to fulfil costumer requirements. This involves translating clients’ needs accurately into design solutions, and then producing goods conforming to the specified design, as shown in Figure 2.5. The fulfilment of customer needs and requirements is carried out in a cycle, where they are captured and converted, through several stages, to a product or service delivered to the customer (Koskela, 2000; Kamara and Anumba, 2000; Smith et al., 2001).
Huovila et al. (1997) suggest that the quality of design can be improved by increasing the amount and quality of information about customer needs and requirements, for instance, through rigorous requirement analysis, systematised management of requirements, and collaborative iterations. Besides, value generation also depends on the skills of the design team (Cooper and Press, 1995), i.e. an efficient design process does not necessarily lead to good design whoever the design professional is.

![Figure 2.5: Value generation concept of design and product development](image)

**The concept of process adopted in this research**

Transformations, flows and value exist as different aspects of processes. For instance, each design task is in itself a transformation, and it is a stage in the total flow of design. Also, internal and external client requirements direct the transformation of input information into the design solution. Therefore, the three views should be approached in an integrated fashion (Huovila et al., 1997; Koskela, 2000; Ballard, 2000). Indeed, the importance of analysing the flow of information as well as value generation aspects of design has been well acknowledged in the literature (see, for instance, Cooper, 1998; Austin et al., 1994; Cooper and Press, 1995; Anumba and Evbuomwan, 1997; Barrett and Stanley, 1999; Winch, 2002).

Furthermore, there are shortcomings in analysing processes only as transformations. For instance, considering that the total amount of work can be divided into parts and managed as if these parts were separated is not sufficient to improve design (Huovila et al., 1997). This is because each task has an impact on the timeliness and on the quality of output of the subsequent tasks. Lindsay et al. (2003) supports this argument stating that the traditional approach to input-process-output lacks concepts to model coordination activities involving actors, information exchanges and coordination structures, which have important influences over the quality of the process. By conceptualising processes as transformations, flows and value generation, such considerations become possible.
Finally, the aim of a process is to produce a product that fulfils clients’ needs. Process activities are related to one another by a trigger relationship, and are also triggered by external events representing a process starting with a commitment to a client and ending with the termination of that commitment (Winch, 2002; Linsay et al., 2003). It has been argued that in construction, focus should be given to fulfilling clients’ needs in order to deliver better quality throughout the industry (DTI, 2002). Conceptualising process as value generation is beneficial as it makes the focus on clients needs more explicit (Koskela, 2000; Ballard, 2000).

In summary, a process is conceptualised in this research as composed of transformations, flows and value generation. Focus is given to the product development, and this is justified in the next section.

2.2.2 Product Development Process (PDP)

Product development has been an explicit topic of study primarily within industrial or manufacturing engineering, with occasional forays into construction (e.g. Koskela, 2000). Most studies examine the management of new products, as well as the processes used for developing an idea or need into a finished product, with the associated support and services (Reinertsen, 1997).

Ulrich and Eppinger (2000:2) define the product development process as “the set of activities beginning with the perception of a market opportunity and ending in the production, sale and delivery of a product”. Those authors stress that it is necessary to bring together the main functions of the enterprise, i.e. marketing, design and manufacturing to achieve successful PDP. Smith & Morrow (1999) and Hales (1993) define product development as the process of converting an idea, market needs or client requirements into the information from which a product or technical system can be produced. Nonetheless, such definitions do not elucidate when product development finishes and physical production starts.

Clark et al. (1992) discuss the dichotomy between product development and production, stating that design produces a product much as any other process produces a product, and the design product differs only in the sense that it is information rather than a
physical asset. The authors also argue that both design and physical production have outputs of two types, i.e. physical and information, but the physical outputs differ in their use (e.g. prototypes are used to refine design). Ballard (2002) supports the idea that product development is principally a production process. The author states that repetitive production starts only after the production of the first copy, which acts as the prototype for both the product and the physical production process. Accordingly, product development includes the production of the first batch of the product.

In this research, the product development process is conceptualised as the set of activities needed for the conception and design of a built product, from the identification of a market opportunity to its delivery to the client. Therefore, it includes design related activities that occur during physical production. All activities of the physical construction are not considered to be part of product development, although the interfaces\(^6\) between design and other processes are part of it. While most of the tasks consist of design work, there are other types of activities involved in product development, such as financial evaluations, and customer surveys (Cooper, 1998; Yazdani and Holmes, 1999).

The product development process concept adopted here principally comprises phase zero (demonstrating the need) until phase seven (production information) of the Process Protocol (Kagioglou et al., 1998). Similarly, the concept can be mapped against the RIBA stages, and thus it focuses on stages A until J.

The performance of construction projects is influenced by the interfaces between design and other processes, such as sales and physical production. In fact, some authors have pointed out that the results of research on modelling have had a limited impact in the industry because most studies regarded design as a relatively autonomous and bounded activity, and did not take into account business issues such as availability of resources, time constraints and organisational structure, which are essential considerations for conducting effective product development (Maffin, 1998; Formoso et al., 2002).

Therefore, approaching the preliminary stages of a construction project as a product development process assists in broadening the current view on design, making possible

\(^6\) Interfaces refer to the feedback of information from production to design, as well as physical production pulling design and development activities (see the pull concept in Ballard, 1999)
the analysis of design activities, its interfaces with other processes as well as the myriad business issues involved in it. This research focuses on the preliminary stages of construction since it is at the outset of any construction project that the vast majority of value can be created (DTI, 2002), and therefore at this stage the major benefits from implementing PDP models can be achieved.

The objectives of process modelling are described in sequence. Different types of models and levels of detail in which these can be developed are presented. Following, the espoused benefits of implementing PDP models in construction are set out.

### 2.2.3 Process modelling

Process modelling, or mapping, has been recognised as an important managerial tool (Clark and Fujimoto, 1991; Winch and Carr, 2001). Smith and Morrow (1999) point out that developing models is useful for both learning about the process and suggesting ways for improvement and control. One of the goals of modelling is the creation of predictive models that improve managerial decision-making (Smith and Morrow, 1999) and optimise process predictability. In fact, much effort has been put into devising models for the PDP, most of them for the manufacturing industry.

Accordingly to DTI (1997), process maps are visual documents that should allow for process improvement, making clear individual and collective activities of the project team. Process models should (DTI, 1997):

- be a clear and concise visual aid;
- demonstrate cross-functionality; and
- provide a generic model that can be customised for specific projects.

Two broad types of process maps can be found in the literature, i.e. true maps of what happens (‘as-is’ models), and protocols of what ought to happen (‘to-be’ models) (Winch and Carr, 2001). ‘As-is’ models simply try to depict the process, some focusing on the process as a whole (for instance, Prasad et al., 1998; Yazdani and Holmes, 1999), while others describe parts of the process (for example, Mazijoglou and Scrivener, 1998). ‘To-be’ models provide protocols and tools to support improved product development management. Those models generally aim at organising the work to be
developed as well as the flows of information (Prasad et al., 1997). Usually, they are supposed to be used as templates containing a generic model and a set of tools to be used as checklists of the key steps in a development activity.

Also, process maps can present different levels of detail on the process being modelled. Two different levels are found in the literature, generic or high-level, and detailed level. Models describing the process in a detailed level are usually developed using structured approaches to modelling, the most common being IDEF0 - integration definition language 0 for functional modelling. This approach is derived from information technology systems engineering (Sanvido, 1990), and focuses on information flows. It depicts processes with inputs, outputs, controls (e.g. standards) and mechanisms (e.g. people and tools), and it can reveal increasing levels of detail.

It has been argued that the IDEF0 approach tends to be over-detailed for use by non-specialists, that it tends to ignore the organisational context which structures the flows of information being mapped, and also that it does not allow the identification of non value-adding activities (Kagioglou et al., 1998; Winch and Carr, 2001; Kartam et al., 1997). Furthermore, most published models have a limited scope, which restrict their applicability as a generic reference, and consequently their application into contexts different from the one in which they were originally developed (Karhu, 1999). Also, they tend to fail in providing a broad view of the process due to excessive levels of detail.

On the other hand, generic (phased or ‘high-level’) maps provide an overview of the whole process, describing the main stages and/or activities (Austin et al., 1999). They focus upon flows of information within an organisation and between different actors in a broad perspective. Typically a two dimensional map is developed, describing a dimension of sequence, of stages in one axis, and actors or functions responsible for each sub-process on the other axis (for example, the generic development process proposed by Ulrich and Eppinger, 2000 - Figure 2.6). Also, sub-processes representing specific activities or tasks are usually described through different levels of detail (see section 2.2.1). Deliverables are typically described, and at the end at each stage generally a phase review is defined (DTI, 1997) (see section 2.2.5).
Chapter 2: Literature review and synthesis

Many examples of generic or high-level models can be found in the manufacturing literature (Pugh, 1991; Wheelwright and Clark, 1992; Hales, 1993; Cross, 1994; Pahl and Beitz, 1996; Prasad, 1997; Cooper, 1998; Ulrich and Eppinger, 2000). The stages or phases defined in such models vary in content and number (from four up to nine), and, so far, many of these models present similar basic features (Maffin, 1998). Such initiatives prompted the application of knowledge gained in manufacturing to the problems of the construction process (Anumba and Evbuomwan, 1997; Kagioglou, 1999; Brookes et al., 1999; Bresnen and Marshall, 2001). Even though some characteristics of construction projects are different from manufacturing, the high-level management processes are not considered to be fundamentally different (Brookes et al., 1999; Bresnen and Marshall, 2001).

Figure 2.6: The generic development process (Ulrich and Eppinger, 2000): phases and responsibilities of the key functions for each phase
Chapter 2: Literature review and synthesis

In this way, there has been also considerable interest in the construction industry in developing generic process models (RIBA, 1980 and 2002; BPF, 1983; Cornick, 1991; Kagioglou et al., 1998; Tusntall, 2000; Gray and Hughes, 2001). The insight that construction is a process is not new, but a wider and more integrative perspective is gaining ground. Process mapping is becoming widely recognised and its use in construction is growing rapidly (Winch, 2002).

High-level models are considered generic at a macro level, i.e. they are proposed to be applicable throughout the whole industry and its supply chain. However, it has been argued that the application of generic models might not be appropriate at all levels of the industry. As proposed by Winch and Carr (2001:527):

“The whole incentive for companies to improve and redesign their business processes is to become more competitive … the greater satisfaction of clients and customers is only the means to the ends of beating the competition … in industries like construction, where firms do not posses strategic assets such as sunk costs, locational advantages, or patents, nor where they can compete through cost leadership obtained by capital investment, process capabilities are all they can offer to clients: the ability to design better structures, the ability to better manage supply chains, and the ability to motivate labour.”

The argument therefore focuses on the fact that if processes become common to the whole construction industry through the application of generic models, then firms’ ability to compete with each other can be diminished, leading to lower levels of profitability. Winch and Carr (2001) further suggest that to achieve a generic process model for the entire industry at a level of detail useful enough to provide the basis for standard deliverables and roles is probably unrealisable, since process standardisation is difficult to achieve where customer needs are diverse, even within a single company (Winch and Carr, 2001; Hammer and Stanton, 1999). On the other hand, the aim of generic models is to improve quality levels throughout the whole industry, focusing not only in specific companies’ competitiveness but also at delivering better quality to construction clients (Kagioglou et al., 1998; DTI, 2002). In this way, the introduction of the process improvements (described in generic process models, e.g. reduction of waste) throughout the industry are highly beneficial.

This research focuses on the implementation of ‘to-be’ generic PDP models, but the level of generality that is been looked at is different from the one proposed in the models mentioned earlier. The focus is at the implementation of process models that have been developed within a company (therefore context specific), describing the
company know-how and the improvements needed to their processes. Even though these models are not generic for the whole industry (as they focus on a specific company) they are still generic in the sense that they should be applied to the different projects within the company, as illustrated in Figure 2.7. The tendency for companies to design and implement specific process models is present in manufacturing (e.g. Cooper, 1994; Mill and Ion, 1994; Hammer and Champy, 2001), as well as in construction (e.g. Winch and Carr, 2001; Gray and Hughes, 2001; Formoso, 2002).

Figure 2.7: Levels of generality of processes

A further issue regarding the level of abstraction of process models is related to the need of re-interpretation of the process concepts (Bresnen and Marshall, 2001). High-level models are necessary due to the fact that specific project processes are generally not translatable between projects due to the associated variability and uncertainty, e.g. different procurement methods imposing dissimilar process strategies. On the other hand, because of the generic nature of the model, some of its concepts need to be changed to enable its adaptation to project specific contexts. Excessive or erroneous re-interpretation could make such concepts lose their original aim, and eventually it would be difficult to identify any relationships between the company generic and the project specific models.

Even though the main aim of modelling is the effective use of the model in real life settings, studies tend to focus on the design of the process model, scarcely describing implementation. For example, BPF (1993), Tunstall (2000) and Gray and Hughes (2001) are models which do not present any considerations on implementation.
studies superficially address implementation issues, but the implementation process is not comprehensively analysed nor described. For instance, studies recognise that there is a need to change working methods and behaviour in order to implement PDP models, and the need for adaptation is also acknowledged. The generic guidance on implementation provided in the process research domain is described in section 2.4.

It is here argued that the superficiality of advice in implementation found within process modelling literature has been leading to an excessive focus on the process models themselves, without the appropriate consideration of the importance of implementation. It appears that in some cases models are developed without the appropriate focus on the fact that they are to be used in practice as a means to improve process management. Such excessive focus to the models themselves might be leading to the development of very elaborated models that cannot effectively be implemented. This provides a possible explanation for the low success rates identified in the use of process models in practice (see section 2.3), as companies have been developing models which end up on shelves as they experience difficulties in using them (Lawson et al., 2003).

Therefore, it can be argued that there is a significant gap in the literature between a process model design and its use. In the area of strategic management, much discussion has been taking place on the dichotomy between strategy formulation and strategy implementation. As pointed out by Grant (1997: vii) “a strategy that cannot be implemented is worthless: strategy must be formulated with a view to its implementation”. In the same way, a process model should be designed with a view to its implementation, and as this review shows, this does not seem to have been the case within process research literature.

The development of process models in construction and manufacturing occurred in an evolutionary approach, as improvements in the way the processes can be managed were gradually introduced. In addition, the proposed benefits of PDP models are similar in manufacturing and construction, e.g. stage-gate approach (Cooper, 1994). The benefits of using process models as a way to improve product development management as proposed in construction and manufacturing research efforts are described as follows.
2.2.4 Implementation triggers: espoused benefits of using processes in manufacturing and construction

Different espoused benefits that can accrue from the use process models have been described by a number of authors, such as Kagioglou et al., 1998; Ulrich and Eppinger, 2000; Gray and Hughes, 2001; Cooper, 2001; and Winch, 2002. For companies, the main triggers for designing and implementing PDP models are to achieve some of the claimed benefits. The espoused benefits presented in the literature were here classified under three generic themes: those related to the client, in terms of potential improvements to the product; benefits related to the process, focusing on its characteristics and on the way it is developed; and benefits for the organisation as a whole. These are summarised in Table 2.1 and subsequently discussed.

<table>
<thead>
<tr>
<th>Potential benefits for the organisation</th>
<th>Potential benefits for the process</th>
<th>Potential benefits for the client</th>
</tr>
</thead>
<tbody>
<tr>
<td>• competitiveness</td>
<td>• less time and costs</td>
<td>• better product quality</td>
</tr>
<tr>
<td>• consistency through replication</td>
<td>• better planning</td>
<td>• fitness for purpose</td>
</tr>
<tr>
<td>• optimise predictability</td>
<td>• better and timely information exchanges</td>
<td>• delivered on time</td>
</tr>
<tr>
<td>• support partnering and contractual arrangements</td>
<td>• better communications</td>
<td>• delivered to costs</td>
</tr>
<tr>
<td>• basis for IT systems</td>
<td>• reduce errors and rework</td>
<td></td>
</tr>
<tr>
<td>• educate new employees</td>
<td>• benchmark for improvement</td>
<td></td>
</tr>
</tbody>
</table>

In terms of the organisational benefits, probably the most important issue relates to the possibility of achieving consistency and integration through the replication of managerial practices embedded in the generic process to all projects developed by the company. The replication of the process and its activities, deliverables and functions, makes possible to achieve more predictable outcomes from company projects (Kagioglou et al., 1998; Ulrich and Eppinger, 2000; Cooper, 2001). Indeed, this can be considered as the ends of a process model implementation effort.

The means to achieve this end at the organisational level have been proposed in the literature. First, the careful documentation of an organisation’s development process often helps to identify opportunities for improvement (Ulrich and Eppinger, 2000; Winch, 2002). Second, a process model can act as a means to educate new employees, since it describes the company ‘way’ of developing projects (Gray and Hughes, 2001; Cooper, 2001). Third, it can create the basis for building computer support systems, as the process is predictable (Aouad et al., 1998). Finally, a process model can provide the
basis for contractual arrangements between clients and suppliers, as well as a common language by which stakeholders can properly define and communicate their roles and responsibilities (Gray and Hughes, 2001; Winch, 2002). This also can support partnering by producing consistent processes through which partnered teams can achieve continuous improvement (Kagioglou et al., 1998).

Many benefits have been described at the project level. A development process specifies the phases a project will go through and the checkpoints along the way (Ulrich and Eppinger, 2000; Cooper, 2001). When these are chosen correctly, following the PDP is one way of assuring the quality of the resulting product (Pugh 1991; Ulrich and Eppinger, 2000), reducing cycle times and costs in product development (Reinertsen, 1995; Kagioglou et al, 1998; Cooper, 2001). A process model can also act as a benchmark for assessing the performance of an ongoing development effort. By comparing the actual events to the established process, possible problem areas could be identified, and managed or avoided (Cooper, 1998; Ulrich and Eppinger, 2000).

A PDP model contains milestones corresponding to the completion of each phase (Wheelwright and Clark, 1992; Prasad, 1997). The timing of these milestones anchors the schedule of the overall development project, enabling its planning (Ulrich and Eppinger, 2000; Cooper, 2001). In this way, the model can act as a master plan for the project in hand. The model informs stakeholders when their contributions will be needed and with whom they will need to exchange information (Kagioglou et al., 1998; Ulrich and Eppinger, 2000) contributing for better coordination and communications between specialists. As the right information can be made available at the right time, it is possible to increase the product quality. In this way, the use of process models can assist in reducing errors and omissions, rework, and achieve improved relationships between organisations and between the industry and its client body (Winch, 2002).

For the clients, the major benefits described in the literature relate to the possibility of achieving better value for money through a product free of defects, with fitness for purpose, reasonable running costs, and delivery on time (Reinertsen, 1995; Kagioglou et al., 1998; Ulrich and Eppinger, 2000).

It is here postulated that the espoused benefits of PDP models provide indications into why companies invest time and resources into models’ design and implementation. It is
important to assess implementation triggers within the specific context in which the model is applied to increase understanding on implementation, and on the rationale behind the proposed improvements. It is believed that the triggers for implementing processes in companies will be similar to the benefits on the literature. The next section synthesises the main improvements proposed within PDP models in the literature.

2.2.5 Changes to current practice proposed in process models

To achieve the espoused benefits of PDP models different, yet interrelated actions have been described in the process management literature. These have been grouped into six areas, described as follows (refer to Appendix A for a more detailed discussion).

The first set of actions relates to the definition of process activities. A process model describing activities, deliverables and functions is necessary for integration in the projects developed by a company (Cooper, 2001). Defining activities covering the project from recognition of the need to the operation of the facility has been described as the ‘whole project view’ (Kagioglou et al., 1998). It can assist in achieving consistency as similar sub-processes and managerial principles can be applied to all stages of projects. Also, the definition of stakeholders’ roles and of when their contributions are needed should enable effective decision making throughout the project life cycle (Cooper and Press, 1995; Koskela et al., 1997; Kagioglou et al., 1998; Ulrich and Eppinger, 2000; Cooper, 2001).

The second set of actions considers the redesign of the sequencing of such activities. Many problems of the PDP have been related to the way the process activities are sequenced and, as a result, different strategies have been proposed, e.g.:

- developing the design of the product and of the production system concurrently instead of in a sequential fashion, and overlapping design stages aiming at reducing lead times and increasing quality through concurrent engineering (Anumba and Evbuomwan, 1997; Prasad et al., 1998; Yazdani and Holmes, 1999); and

- reducing time waiting for information and rework through planning, applying tools such as the dependency structure matrix analysis (DSM) (see, for instance, Austin et al., 1994; Baldwin et al., 1999; Koskela and Ballard, 1997; Austin et al., 2000).
The third set of actions take into account the definition of phase reviews, or the stage-gate approach (Cooper, 1994). Gates represent decision points in which the project is approved to continue or is withdrawn (go/kill points). Go/kill decisions can be delayed to allow for flexibility and speed, and the gates are presented as fuzzy gates, which can be conditional or situational (Cooper, 1994). The application of the stage-gate concept to construction has been proposed in the Process Protocol (Kagioglou et al., 1998). The main benefit of the phase review is the progressive fixity of design decisions. This means that some design decisions should not be changed after being approved within each of the phase reviews. A further benefit is that it facilitates a means by which project experiences can be recorded, updated and used, thereby informing later phases and future projects through feedback.

The fourth set of actions relates to the importance of teamwork and coordination between specialists. The need for integrating functions and consulting participants early in the process to provide the necessary knowledge and avoid changes in later project stages has been described (Syan, 1994; Prasad, 1997; Yazdany and Holmes, 1999; Gray and Hughes, 2001). Also, great emphasis has been given to delegating to a stakeholder the authority to co-ordinate the participants and activities of each phase (Kagioglou et al., 1998), as well as the importance of empowering teams to make decisions, thus reducing the effort for information transfer (Tranfield et al., 1998; Koskela, 2000).

The fifth set of actions regards the use of IT. Various technological solutions for collaboration, engineering databases, project intra and extranets, between others are increasingly more important in making product development activities more efficient and to improve communications between the parties involved (Hinks et al., 1997; Soibelman and Caldas, 2000). A process model should enable the effective use and coordination of technology based on a predetermined framework (Cooper et al., 1998).

Finally, the importance of focusing activities to meet clients’ needs and requirements to achieve better value through the process has been emphasised. Different authors proposed improvements to requirements capture that could be introduced through the application of process models (such as Cooper and Press, 1995; Prasad, 1998; Hassan et al., 1999; Barrett and Stanley, 1999; Kamara and Anumba, 2000; Smith et al., 2001). Examples of such solutions include increasing the involvement of end users by identifying, agreeing and recording requirements early in the project life cycle (CRISP,
Also, tools such as quality function deployment (QFD) could be used to support the client requirements capture process as it provides linkages between requirements and solutions (Zairi and Youssef, 1995; Prasad, 1998).

**Implications for the implementation of PDP models in construction companies**

In summary, the actions presented through process management research efforts provide a useful framework for the design of process models by companies. Those could help in focusing the formulation of the process model goals as well as proposed changes to current practices.

The proposed actions to improve PDP management could also be approached as a means to evaluate PDP models, e.g. the model usefulness in terms of improvements necessary and important for the company. It is clear that the improvements proposed in process models developed within companies influence the success of their implementation, e.g. if the process model does not present any improvement considered important by its users, its adoption is unlikely. From this thinking, a research question has been proposed:

- What are the improvements to current practices brought about by process models devised/implemented in construction firms?

### 2.3 Implementation outcomes

Implementation outcomes relate to the benefits that will accrue from the use of a process model in current practice. Up to date, the outcomes from implementation have been less successful than would be expected.

The BPR literature describes low success rates associated with the implementation of process models. Hammer and Champy (2001) stated that regardless of the development of models prescribing how to implement redesigned processes (see section 2.4.6) implementation fails in between 50% to 70% of BPR initiatives. One of the reasons commonly described relates to the narrow focus of reengineering, with inadequate attention to human issues (Cooper and Marcus, 1995; Marjanovic, 2000; Cao et al., 2001), which leads to major resistance to change. Hall et al. (1993) described through a
survey that more than 50% of re-engineered projects provided less than 5% of performance improvement.

In addition, Stickland (1998) suggests that 70% of all companies that embark upon a business process reengineering program fail, and states that the reason for this is related to poor management of the change process. Kotter (1996) states that companies suffer from problems in managing change as they look for short cuts by expecting individuals to execute new working practices without training or awareness of its need. Cooper (2001) further supports this idea, stating that lack of training and education is responsible for scepticism and lack of acceptance when processes are implemented. Cooper (2001) also conducted a survey revealing that most process model implementation attempts suffered start-up problems, which demonstrates that implementation is a big challenge.

Smith and Morrow (1999) identified problems in the applicability of process models through a review of PDP modelling in manufacturing. Accordingly, even though applicability to projects is one of the most important criteria through which process models should be analysed, all models identified by these authors failed against this criterion. This supports the proposition that process models have been devised in research without fully considering implementation (see section 2.2.3).

A factor that has certainly contributed to unsuccessful implementation outcomes is that producing clear evidence of performance effects (i.e. measuring benefits generated from a process model use) is a difficult endeavour, especially in project environments like construction (Bresnen and Marshall, 2001). In construction it is very difficult to compare results between projects due to their variability, and so it is also difficult to establish links between the performance of a project and the use of a process model. It is believed that this influences the motivation of users as benefits resulting from the effort put into changing practices are difficult to be clearly demonstrated.

The above mentioned points imply that the organisational context is important in determining the relevance of a process model (Pettigrew, 1987; Bresnen and Marshall, 2001), e.g. in providing appropriate training and in clearly demonstrating benefits. The external context also plays an important influence (Pettigrew, 1987). For instance, economic and market conditions could impinge pressures onto companies (e.g. need for
faster project definition and delivery) which could make implementation difficult as the project team would not have the necessary time available for training and to introduce changes to current practices. Even though it is clear that the organisational and external context are important in determining a PDP model relevance, those issues seem to have been abstracted away from most research into process model design.

Discussion
Different process concepts and principles have been proposed in the literature, and a number of espoused benefits of adopting processes have been described. However, the understanding of process model implementation is limited, and there is not enough empirical data presented on implementation. As a consequence, there is little evidence that construction companies have accomplished the espoused benefits of using processes (Smith and Morrow, 1999; Austin et al., 2001; Winch, 2002; Lawson et al., 2003).

There are three main causes for the superficiality of the advice on implementation found within process management literature. First, the development of a PDP model is a difficult exercise which involves different knowledge domains, and there is usually a need for a long-term effort to design such models (Formoso et al., 2001). Due to this factor, studies tend to put great focus on the generation of the models leaving implementation issues as an area for further research. Second, most models found in the literature have not been developed with a basis of sound empirical evidence, nor have they been empirically validated, which suggests that the research strategies that have been applied do not lead to the consideration of implementation. Finally, and maybe more importantly, implementation issues are multifaceted, complex, and tend to be context specific. It is here postulated that the way to achieve research outcomes that are applicable in practice is by approaching both process model design and implementation. Therefore, such knowledge should be brought together to allow for the achievement of successful outcomes.

Additionally, as construction companies design ‘in-house’ process models, the improvements to current practices proposed in such models need to be addressed, as they will directly influence implementation success (e.g. if a model does not present improvements considered important by users, its adoption is unlikely). Also, companies
will invest in process models aiming at achieving specific benefits, and implementation success should be measured with the basis on the accomplishment of such benefits.

In summary, little attempt has been made within process management literature to understand implementation. There is a clear assumption in both industry and academia that a firm’s product development performance can be improved through the effective use of generic process models. However, research has not been able to produce a sound theoretical basis to support their uptake. As a result, the construction industry has failed to benefit from the implementation of standardised processes (Austin et al., 2000). Through the identification of the reasons why implementation efforts tend to be unsuccessful, a richer understanding of this phenomenon can be achieved. From this perspective, the following research question is proposed:

- Are the espoused benefits of process models achieved in practice according to the perceptions of process model users? And if not, why are process model implementation efforts often unsuccessful in practice?

2.3.1 Theoretical framework and research hypotheses derived from the process literature

The following issues can be described regarding the design and implementation of PDP models drawing from construction and manufacturing process management literature:

- prior to the development of a PDP model within a company, the espoused benefits and the proposed improvements to current practices should to be clearly established (Hales, 1993; Mill and Ion, 1994; Kagioglou, 1999; Cooper, 2001);
- different criteria can be used to evaluate process models developed both in research and practice (Smith and Morrow, 1999), e.g. proposed improvements, simplicity and clarity in representing activities;
- the implementation of PDP models will involve their adaptation and adoption into specific project contexts, leading to their use to guide the actions of the project team (BPF, 1993; Kagioglou et al., 1998; Gray and Hughes, 2001; Reinertsen, 1997; Cooper, 2001); and
- different factors can affect implementation in a positive or negative manner, which vary from context to context. These should be assessed and managed as
part of an implementation effort (Peppard and Rowland, 1995; Karlsson and Ahlstrom, 1996; Yung, 1997; Eldin, 1999; Vakola et al., 2000; Kuruppuarachchi et al., 2002).

These issues are the basis from which the conceptual framework, presented in Figure 2.8, is grounded. This study approaches implementation as the adaptation and adoption of generic product development process models into project specific processes, within a company specific context.

![Figure 2.8: Theoretical framework on the implementation of product development processes in construction](image)

First, implementation is analysed with regards to the need to formulate an implementation strategy considering model design and implementation. It is postulated that an improvement need will be leading to the establishment of the strategy and the (re)design of the process model. The expected goals and benefits of implementation are thus defined.

Second, implementation is analysed in relation to the need to adapt the process model to the specific project context to suit organisational and project needs. This specific context can potentially be highly variable. The complexity of the process model content
and the degree of changes to be introduced in working practices will directly influence the degree of adaptation needed, and this in turn will also influence the implementation success. It is postulated that the greater the adaptation needed, the greater the potential difficulties in implementation. How process models’ adaptation occurs has been generally overlooked and it is usually not explicitly addressed or registered in practice and in research.

Third, implementation is approached as the adoption of the project specific model to effectively manage product development, guiding the actions of the project team. This will be dependent on an array of issues, that varies from the complexity and applicability of the improvements proposed in the model, to the extent to which people believe it effectively help improving performance (section 2.4.3).

While the project is being developed, different factors will affect the PDP model use. Based on the identification, analysis and feedback of those factors, improvements can be proposed to the model content and to the implementation process, and a cycle of continuous improvement could be established. The validity of the framework presented in Figure 2.8 is tested through this research, and the factors affecting implementation are identified and analysed.

**Research hypotheses based on process research**

A process model will only be successfully implemented if it is perceived to be useful and applicable, i.e. the value of its content influences successful uptake (Reinertsen, 1995; Smith and Morrow, 1999), as the users perceive benefit in changing their current ways of working. Accordingly, research hypothesis 1 is proposed:

**H1**: Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful.

The validation of the process model will be dependent on pilot implementations, as well as on the demonstration of the improvements achieved via measurement and/or other means. In such way, the model could be used as a vehicle for engaging the model users. It is postulated that not demonstrating improvements negatively influences
implementation, mainly through lack of motivation, i.e. efforts and resources are invested, but benefits are not clearly demonstrated. This thinking generated research hypothesis 2:

**H2. Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use.**

Another important issue on implementation is the need for adaptation, which involves re-interpretation of the concepts described in PDP models. As argued by Bresnen and Marshall (2001:341):

“ideas, such as managerial recipes, do not remain unchanged as they travel. Instead, they are subject to intentional and unintentional modification and interpretation as they are communicated, adopted and enacted”

Therefore, the generic process model needs to be interpreted and modified before its effective use. From this thinking, research hypothesis 3 is proposed:

**H3: Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide the actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation and adoption does not occur.**

It is therefore postulated that implementation will be unsuccessful if the process model is not adapted and adopted at the project context. It is also believed that an implementation strategy should demonstrate the need for adaptation, describing guidelines for it. It should also clearly demonstrate goals and benefits of adopting a PDP model to manage the different company’s projects.

### 2.3.2 Summary

Section 2.2 presented the main issues regarding the triggers and outcomes of process models implementation, i.e. why implementation is needed, what it seeks for and what the main improvements to current practices involved in it are.
The concept of ‘process’ as adopted in this research was presented, followed by a definition of the PDP. Subsequently, types of process models and their level of generality were discussed, and the focus of this research at to-be models generic at the company level was pointed out.

Due to the espoused benefits from the application of generic processes in construction, a number of research attempts have focused on devising process models for design and construction. To date, many of these models present similar characteristics, which demonstrate a certain level of agreement within research efforts on how a process model should be described (e.g. phases, stakeholders and activities/procedures) and on the main improvements to current practices (e.g. phase reviews). Even though any process model should be developed with a view to its implementation, research efforts have focused on the models’ design, leaving implementation at a marginal level.

It is necessary to assess the current views and advice on the implementation process to reach an understanding of PDP models implementation within construction firms. Next section describes the generic guidelines on process models implementation identified within two bodies of knowledge: (a) process management, including NPD and BPR; and (b) organisational change management, which provides a fruitful perspective from which to better understand implementation.

### 2.4 Implementation process

The ‘implementation process’ this research is concerned with refers to the steps that a firm goes through to adapt and adopt a PDP model. As mentioned earlier (section 2.3), the literature on process management presents some generic guidelines on the implementation process, which are briefly described as follows.

#### 2.4.1 The implementation of product development process models: current understanding in the construction and NPD literature

The construction process literature offers little understanding and advice on how to implement process models and, as a result, there has been a low uptake of such models in the industry (section 2.2.3). In the New Product Development (NPD) literature, some
advice is presented on implementation, but mainly common issues such as the need for support from top management are described (for example, Cooper, 2001). Support for these statements is given as follows.

One of the most prominent research outputs into the design and construction process is the process protocol (Kagioglou et al., 1998). Within it, some important, yet generic implementation guidelines are presented. The significance of the process representing a generic and adaptable set of principles that allow for a consistent application in a repeatable form with the scope for atonement for the specific detailed circumstances of individual projects, teams and client needs has been emphasised. The research also stressed that processes should be interpreted, adopted and applied in a flexible manner across projects by the professionals involved. Other considerations to allow the successful use of the model have been described (Kagioglou et al., 1998):

- the uptake of the process would depend greatly in its ability to deliver measurable, identifiable and attributable benefits in terms of the standard metrics for efficiency of cost, quality and time;
- need for coordination to implement the process in terms of the changes within individual organisations and across organisations, as well as the need for communication channels between teams to be maximised;
- need to have an explicit information management protocol linked with the process, which could be either paper or IT-based; this should integrate the process, IT, and the data being collected and re-used from previous projects;
- the need to have one stakeholder (e.g. process manager) responsible for implementation; and
- need for a high degree of management, which would add costs to the existing project; however, the net gain associated with having a systematic and managed process would probably outweigh the cost of administrating it.

All these issues must be considered in any attempt to implement PDP models, but more information is needed to support its adoption within companies. For example, how to adapt the model to individual circumstances to allow flexibility across projects needs definition, and which specific benefit measures could be applied should be determined.
Cornick (1991) presents case studies where quality management systems for the design process were applied. In this study, implementation is addressed as the use of quality procedures. The author states that the client should provide the general framework for the project quality plan, and then each designer or design team should develop their own quality plan for controlling their contributions to the project. This is an approach that could potentially bring fragmentation problems between project teams, since each team would be working under different procedures. Furthermore, it appears to be erroneous to expect that the client should be responsible for organising the work of the project team. On the other hand, this approach represents the conventional way in which design teams are usually managed.

The NPD literature provides information on implementation by presenting ‘processes’ to implement process models. Implementation strategies/steps are presented usually based on empirical research drawing from experiences within successful firms. For instance, Smith and Reinertsen (1995:257) state that: “to achieve the full potential of rapid product development demands a fundamental change in organisational behaviour”. The same authors emphasise that top management has an essential role in implementation by:

- being truly interested in the improvement (in the authors approach, faster product development);
- providing leadership in justifying the importance of rapid product development, communicating its importance and goals throughout the organisation, and maintaining awareness of it over time;
- recognising/rewarding achievements of the team, encouraging desirable changes in behaviour and accepting mistakes as part of the learning process.

Smith and Reinertsen (1995) also describe: (a) need for planning the implementation activities; (b) need to implement the PDP model from the beginning of a project; (c) getting the right leader and providing training for the team; (d) getting management to facilitate the process; (e) using past experiences as means to demonstrate how behaviour can be changed; and (f) gradually roll-out implementation. Those guidelines present issues that have been widely acknowledge as necessary for the implementation of processes within organisational change literature (e.g. Yung, 1997; Fowler, 1998; Vakola et al., 2000; Hammer and Champy, 2001).
Cooper (2001) also depicted the application of the stage-gate approach in manufacturing firms. The author presents a stage-gate process for designing and implementing a stage-gate process. It comprises three stages:

- **stage 1 - defining the process requirements**: including task force definition, executive sponsorship, process audit, problem detection, external and internal benchmarking;
- **stage 2 - designing the process**: including design the process through a series of rounds, iterations with users and management, feedback sessions, engaging senior management;
- **stage 3 - implementing the process**: including training, internal marketing (buy-in), bringing projects into the process, a process owner, documentation, development of IT support and database.

Therefore, implementation has been approached as an organisational change phenomenon within NPD literature. Nonetheless, the advice on implementation tend to describe general issues, such as the need for planning the implementation process, the importance of leadership and support from top management, and need for training. Furthermore, implementation is described through steps that should be conducted (e.g. having a process to implement a process). It could be argued that if there were a need for a process model to implement a PDP model, maybe there would be a need for a further process prescribing advice on the process to implement PDP models, which could lead to a never-ending cycle!

Changes proposed within process models are often significant and can cause intra-organisation tensions (Peppard and Rowland, 1995; Karlsson and Ahlstrom, 1996). People, processes and IT undergo significant change, learning and adaptation in response to the introduction of a PDP model. In order to support this, changes might occur in the organisational structure as well as in the way people conduct and manage product development activities. The literature presents examples of change projects that have gone wrong, which demonstrate that organisations do experience problems in managing change effectively (Nadler, 1993; Quinn, 1993; Hammel and Prahlad, 1994; Hamlin et al., 2001). In other words, change management is a challenge for those directing the introduction of improvements (Kuruppuurachchi et al., 2002). Therefore, it
is important to carefully evaluate the change strategies available to management at different levels that can help to bring about successful implementation.

The next section is concerned with synthesising concepts from the area of organisational change management which can contribute to the understanding of PDP models’ implementation. It does so by describing the different levels and frequencies at which change can occur and presenting implementation strategies or methods based on the planned approach to change.

2.4.2 Organisational change and process models’ implementation

From an organisational change perspective, a PDP model implementation concerns a managerial decision to change the organisation’s structure or way of functioning. After such a decision is made, the design of a PDP model describes ‘what’ will change, while implementation plans describe ‘how’ change will occur.

Managing change is seen as a matter of moving from one state to another, specifically from the ‘problem’ state to the ‘solved’ state. It involves problem diagnosis and analysis and setting goals at various levels and different areas and functions. Also, ends and means are discussed, and planning is done together with efforts to achieve buy-in, support and commitment (Hamlin et al., 2000; Nichols, 2000). Similarly, the implementation of PDP models can be understood as moving the process from a ‘problem’ state to an ‘improved’ state. Indeed, as-is models usually describe this problem state, while to-be models describe the improved state (see section 2.2.3).

The way changes within organisations are managed, and the appropriateness of the approach adopted have major implications for the way people experience change and for their perceptions of the outcomes (Burnes, 2000). Change happens at different levels, and such levels need to be considered as part of its management. The next section discusses change at the organisational, group and individual levels.

2.4.3 Individual, group and organisational change levels

Organisational change can take place at three different levels, which of each has been studied under different theories (Makin et al., 1996; Stickland, 1998; Burnes, 2000): (a)
theories that focus on the whole organisation; (b) theories that focus on dynamics of
groups or teams; and (c) theories that are centred on individual-behavioural change. The
implications of each of these theories to the implementation of process models are
discussed as follows.

**Individual perspective**

The necessity to change an organisation to cope with internal and external environment
changes leads to the need of changing the behavioural patterns of an organisation’s
employees. Individual change has been regarded as the basis for all change, given that
unless individuals change in some way, nothing else changes (Makin et al., 1996). As a
result, it can be said that any business improvement initiative tries to make employees
adopt new patterns of behaviour. If these new behaviour patterns are not achieved, the
improvements intended in those initiatives will not be accomplished.

At the individual perspective, the focus is often on developing skills for present and
future task needs, and is thus based on assumptions about how people learn and
consequently change behaviours (Makin et al., 1996). Furthermore, individual theories
emphasise the importance of understanding individual needs and motivations in order to
unlock human resistance to change (Green and Butkus, 1999).

Two major schools of thought support this perspective, the behaviourist approach and
the cognitive approach (Burnes, 2000; Makin et al., 1996). In the behaviourist theory,
all behaviour is considered to be learned. Therefore, behaviour modification involves
the manipulation of the external stimuli that acts upon the individual. From the
cognitive approach, behaviour is not seen as just a product of external stimuli; rather, it
arises from how the individual interprets these stimuli. Therefore, learning is
approached as a process of gaining or changing insight, expectations and though
patterns. Burnes (2000) also states that both schools of thought have proven influential
in the management of change, through the combination of intrinsic and extrinsic
motivators.

From the individual perspective on change, the following implications could be drawn
in terms of the implementation of process models:
• there is a need for the model users to change their behaviour in some way to allow the successful implementation;
• individuals need to be motivated to implement; external and internal stimuli can provide such motivation, e.g. considering the process model users’ needs as part of the implementation strategy;
• as a consequence, it is important that users participate in strategy formulation and in the model design, as this assists achieving commitment to implementation; and
• users need to perceive benefits arising from the PDP model use, e.g. people’s beliefs in the good practices that are proposed as part of the process model.

Social norms also play an important influence in determining perceptions, motivations and behaviours (French and Bell, 1995). The influences of the group level to implementation are described as follows.

**Group level**

At the group level, change dynamics are viewed in terms of group values, norms and roles, involving strategies for team building (Makin et al., 1996). Burnes (2000:260) described:

“Norms are rules or standards that define what people should do, think or feel in a given situation…. Roles are patterns of behaviour to which individuals and groups are expected to conform. In organisational terms, roles are defined by job descriptions and performance targets… Values are ideas and beliefs which individuals hold about what is right or wrong. Values do not refer to what people do or think or feel in a given situation; instead they relate to the broader principles which lie behind these.”

If effective change is to be achieved, group characteristics need to be addressed and understood prior to attempting planned change (Pettigrew and Whipp, 1991). Distinctions are made between formal and informal (or explicit and implicit) norms, and organisational change is approached in terms of interactions, conflicts and relationships between groups, with particular groups presenting resistance to change (Makin et al., 1996).

The implications for PDP models implementation within companies are:

• group characteristics (i.e. norms, rules and standards) need to be addressed in a process model implementation effort;
• different groups in a company can have diverse views with regards to implementation; this can potentially lead to conflicting actions between such groups (French and Bell, 1995); therefore, it is important to achieve consensus with regards to the PDP model characteristics and implementation strategy between the different user’s groups; and
• the clear definition of stakeholders’ roles in the PDP model (in terms of defining job descriptions), and as part of the implementation strategy (in terms of implementation responsibilities) potentially influences implementation success.

Even though the group approach to change has proved to be influential in developing theory and practice on change management (French and Bell, 1995), it is important to look at macro-level dynamics of change which happen at the organisation as a whole (Nelson and Winter, 1982). The analysis of the organisational level of change aims at describing such macro-level dynamics, and it is described as follows.

Organisational level
Theories based at the level of the organisation see change originating mainly from two sources, i.e. interactions between the sub-systems from which they are composed, and interactions across their boundaries with the external environment (Stickland, 1998; Burnes, 2000). Those are based on a method of describing and evaluating these sub-systems, in order to determine how they need to be changed so as to improve the overall functioning of the organisation (Burnes, 2000). In this approach, change analysis and intervention tends to be holistic in nature.

According to Burke (1980), cited by Burnes (2000), the open systems approach to change is informed by three factors:

• sub-systems are interdependent: if alterations are made in one part of the organisation without considering its dependence and impact on the rest of the organisation, the outcome may be sub-optimal;
• training, as a mechanism for change, is unlikely to succeed on its own: since it concentrates on the individual instead of the organisational level, it may lead to individual change and in some cases to group change, but there is not enough evidence to support that this will in turn change the whole organisation; and
• the organisation needs to direct the competence of its employees to be successful: this is likely to require changes to norms, reward systems, and work structures, and those need to be addressed at an organisational perspective.

Accordingly, implementation should consider changes not only to the PDP, but also the effects it can have on the other parts of the organisation. Training should be part of the implementation strategy, but its success should not rely solely on training. Changing norms, involving users and creating reward systems are examples of further means to support successful implementation at the organisational level.

As stated earlier, introducing improvements is concerned to changing behaviour, which in turn can be achieved through learning. The learning styles of individuals and organisations have been subject of study, in an attempt to improve knowledge levels and change organisational behaviour (Argyris and Schon, 1978; Senge, 1990; Nonaka and Takeuchi, 1995). Argyris and Schon (1978) proposed a seminal model of learning:

- **level I: single-loop learning**: is the most fundamental and passive learning style. It is an adaptive learning that involves detecting and rectifying errors or exceptions within the organisation’s existing practices in order to ensure its objectives are met. Examples include monitoring quality standards and adherence to sales targets in order to detect and correct variances. Since it focuses on immediate problems, it limits knowledge development and behaviour modification.

- **level II: double-loop learning**: It involves questioning the overall effectiveness of the company’s norms, values, policies and practices, and suggests changes that may be required to improve performance. This is a learning that involves reconstructing basic aspects of an organisation’s operations. For example, it might involve questioning if some operations should be outsourced rather than continue being developed within the organisation. Therefore, new practices, policies and norms of behaviour are generated.

- **level III: triple loop learning**: this involves questioning the whole rationale for the company and, therefore, radically transforming it. As an example, this might involve a manufacturing organisation attempting to transform itself in a services organisation, with all the implications for culture, structure and practices that may occur.
Although companies are one building block, in practice success tends to depend on individuals (Barrett & Stanley, 1999). In the same way, the success of an implementation effort will also depend on individuals. The effectiveness of a PDP model implementation effort relies on the occurrence of at least single and double loop learning, involving questioning of companies norms, values and practices with regards to product development, leading to changes in the behaviour of the members of the organisation. Thus, in parallel with having technical expertise within the implementation team, it is also important to have people with complementary learning styles to better address the different stages of the implementation process.

In summary, the individual, group and organisational perspectives on change focus on different aspects and, therefore, each has different implications for what change takes place and how it is managed (Hamlin et al., 2001). Furthermore, it is possible to argue that the approaches are complementary. As stated previously, to change anything requires the consent of people and groups that compose an organisation, and changes in one part of an organisation will indeed influence in some way other parts or groups within and outside it. Therefore, the need for change management at the three levels should be considered.

The magnitude of change will also have implications on how implementation should be managed. In the literature, change has been placed along a continuum that ranges from incremental to radical change. An appreciation of whether an organisational change is to be a continuing feature or a one-off event and if it is small or large scale play an important role in judging the appropriateness of particular approaches to managing change (Sanban et al., 2000). The main differences between incremental and radical changes are briefly presented next.

### 2.4.4 Incremental and radical change

Incremental change has been described as first order change, and radical change as second order change (Levy, 1986). A slow and incremental process characterises first order change. Second order change is radical, multidimensional and revolutionary in nature, and therefore it changes the way the organisation is designed. The single loop learning can be related to first order change (i.e. detecting and modifying errors to
continuously improve), while double loop learning can be related to the second order change (i.e. creating major change by questioning the effectiveness of the whole company). The distinction between the magnitudes of change is useful as it highlights two very broad sets of defining attributes of change (Garcia and Calantone, 2002).

Such distinction has also been applied in recent methods for business process improvement, which tend to fall into one of these philosophical approaches. For instance, BPR is based on the radical rethinking and redesign of business processes (Hammer and Champy, 2001), while Continuous Improvement (CI) focuses on the achievement of incremental innovation through many small improvements on existing systems (Bessant et al., 1994; Savolainen, 1999). Assessing whether a PDP model presents radical or incremental changes helps the formulation of a suitable implementation strategy. The level of innovativeness of a PDP model should be accessed within the company context (Garcia and Calantone, 2002).

Strategies to implement change have been described in the literature. Since the beginning of the century, different approaches on how to view the organisation and how to manage change have emerged. The scientific management, human relations and contingency theory are regarded as the basis for the emergence of approaches such as total quality management (TQM) and BPR (Peppard, and Rowland, 1995). The next section briefly presents such schools of thought in change management.

2.4.5 Schools of thought

Scientific management
The classic or scientific-rational school of organisational management emerged during the industrial revolution, where the organisation of work and the efficient use of labour became an issue to organisations. The understanding of the concept of change was limited during this period (Nelson and Winter, 1982).

Change was basically directed into increasing control over individual actions, ensuring they were subordinate to corporate interests in a belief that it was based on scientific principles (Burnes, 2000). Change was functionally oriented, concerned with altering job actions (task level) to achieve maximum efficiency. There was no conception of external sources influencing an organisational environment, nor any significant internal
mechanisms for adaptation (Hamlin et al., 2001). Therefore, change was planned and approached at an operational level. It was believed that there was a single ‘best way’ for organising companies, and that it would be very similar for all companies.

**Human Relations**

The human relations approach emerged around the 1930’s as a reaction against the mechanistic approach advocated by rational theorists (Burnes, 2000). The approach emphasised the following (Stickland, 1998; Burnes, 2000): (a) the cooperative and social nature of organisations as opposed to the mechanistic view; (b) the importance of considering human needs, attitudes and values; organisations were considered to be composed by informal structures, rules and norms as well as practices and procedures; and (c) the emotional and psychological side of the worker, i.e. peoples’ emotional and social needs can have more influence on their behaviour at work than financial incentives.

Experimental studies of group dynamics and behaviour led to an understanding of the importance of considering softer issues within organisational change, which are indeed still under investigation (Makin et al., 1996; Hammin et al., 2001). Change was still being conceived as having no influences external to the organisation, and it was still believed that a ‘best possible way’ to manage organisations had been discovered (Stickland, 1998; Burnes, 2000).

**Contingency theory**

The contingency theory came to light in the early 1960’s presenting a new shift in thinking concerned with going away from the view that there needs to be ‘one best’ approach to operating and managing all organisations (Nadler, 1993). Therefore, it considered that the operation of an organisation is dependent (therefore contingent) on the situational variables it faces: environment dependence, uncertainty and relevant technology and organisational size (Burnes, 2000; Stickland, 1998). As no organisation will face the same contingencies, they need to have different structures and operations to cope with those dissimilar contingencies. However, despite the recognition of the uncertainty associated with the external variables, it has been argued that the contingency approach remained rational and deterministic in style (Burnes, 2000).
Commonalities
Stickland (1998) describes common themes between the three approaches:

- organisational change is essentially a planned activity, implemented in a deterministic manner;
- the dynamics of an uncertain environment are not considered to affect change;
- there is a perceived optimum solution which a given change seeks to realise;
- change is sequential and is perceived as a one-dimensional phenomenon.

Stickland (1998) states that the extent to which those common themes to change still dominate change thinking today should not be underestimated. Burnes (2000) and Bresnen and Marshall (2001) support this idea, stating that managers look for simple solutions, and this is why the classical approach with its straightforward mechanical view of organisations has proven enduring, despite strong evidence of its lack of suitability for many situations. Burnes (2000) also states that the search for ‘quick fix’ solutions to the problems of organisational life have been manifested in many ways in the last decade. These could bring benefits to organisations, but the need for overall, long-term plans regarding the complexity of change scenarios should be considered.

The implementation of a PDP model is a process that should be planned considering the multidimensional aspects of change, and the specific dynamics of the environment in which the model is to be implemented should be considered. It is postulated that the planned approach to change can provide insights into how an appropriate implementation strategy can be formulated and conducted. The planned approach offers methods or strategies that could be applied in a PDP model implementation effort, which are briefly described next.

2.4.6 The planned approach to change: implementation strategies
Planned change is a term that has been first introduced by Lewin (1947) in order to distinguish between the changes that were planned by an organisation from the changes that occur naturally, that might happen by accident or that are forced upon a company. Planned change events are usually achieved via some implicit or explicit methodology. Many approaches are described through ‘best practice’ advice and guidance on the ‘how to’ of change management (French and Bell, 1995).
According to Hamlin et al. (2001), these models range from straightforward practical guides written by consultants based on their practical experiences, through textbooks written by academics mostly for the educational market. The same authors pointed out criticisms in both lines, as the first can be too pragmatic, to the point of being no more than prescriptive and over simplistic, while the second can be so theoretical as to appeal only to academics and students. Nonetheless, there is a need for some shape and rigour in any change intervention (French and Bell, 1995). Hence, those models can be informative in understanding how an organisation could implement a PDP model, having shaped and challenged thinking about change management.

Methodologies for achieving planned change could be categorised in different ways (Stickland, 1998). Hence, the next part of this section has been divided as follows. First, the influential change model developed by Lewin (1947) is described, and its implications discussed. Second, examples of models from three different approaches to planned change are presented as they provide different perspectives on the change process as well as on factors affecting change. Finally, BPR as an approach to organisational change is discussed, as it focuses on the design and implementation of new or redesigned processes.

**Unfreeze, move, refreeze**

Lewin (1947) presented a three-step planned change model that has been seminal in understanding the change process, providing a powerful cognitive tool to understand change situations (French and Bell, 1995). The author believes in facilitating learning and also enabling individuals to understand and restructure their perceptions of the world around them as key factors to enable change. The process of unfreezing the old behaviour (or situation), moving to a new level of behaviour, and refreezing the behaviour at the new level proposed by Lewin (1947) is described:

- **unfreezing the present level:** a procedure to disengage the organisational members subject to the change from their conventional practices; it draws attention to and examines the differences in what people do and believe now, from what they would like to be and do;
- **moving to the new level:** the development of new values, attitudes and behaviours; that is, having analysed the present situation, identified alternatives
and selected the most appropriate, action is needed to move to the more desirable state, involving people who will be affected; power structures are likely to be changed, therefore resistance may be evident from certain people.

- **refreezing to the new level**: involves stabilizing the new state of equilibrium of the person and the organisation, to ensure that the new ways of working are relatively safe from regression; norms of work and organisational policies are developed and ideally become embedded into the organisation’s culture; rewards are often important in assuring that refreezing does take place.

Within the context of this research, the design of a process model, its adaptation and adoption can be related to the change process proposed by Lewin (1946). The design of a process model is approached as a means to ‘unfreeze’ the way the PDP is current developed within the company, demonstrating problems and areas. The adaptation of the model and its adoption into a specific project can be analysed as moving from the ‘old’ way of developing the project (current working practices) to the ‘new’ one, as envisaged in the PDP model. The adoption of the model into a different company’s projects (its replication) is approached as refreezing, or stabilising the new working practices and embedding them into the company. This thinking informed the theoretical framework that ground this research, presented in section 2.3.1.

The three-step change process has been further developed by other authors in an attempt to enhance its practical value. Indeed, it has been suggested that through an investigation of any of the abundance of approaches to create and manage change, this three-step model will emerge (Burnes, 2000). Different models have been developed under somewhat contrasting theoretical focuses, i.e. the human resource, political and cultural and eclectic approaches to change. Examples of such models are here presented since the way change is brought about is dependent on a company’s strategies, culture and mode of operation, and therefore different strategies might be suitable for different companies (Hamlin et al., 2001).

**The human resources models of change**

The human resources models of change emphases two aspects in the management of change (Kolb et al., 1991). First, they approach change as a sequential process. Second, they place significant importance on the relationship between managers and those who will be affected by the change, as well as on the appropriate participation of these
people in the change process, focusing on beliefs, attitudes and values. Figure 2.9 presents the human resources change process proposed by Kolb et al., (1991).

**Figure 2.9: Human resources change process (Kolb et al., 1991)**

This model can be directly related to Lewin (1947) model: scouting, entry, diagnosis and planning can be seen as unfreezing strategies; action and evaluation describe moving strategies; and institutionalisation represents refreezing.

**Political and cultural models of change**

The political and cultural approaches to change are based on the following major assumptions: (a) companies are viewed as coalitions composed by a number of individuals and interest groups; (b) individuals and groups are seen as differing in their values, needs, goals and aspirations, and those are prone to attempt to have their values, needs, goals and aspirations prevail; (c) therefore, power and conflict are endemic in companies; (d) the political landscape is shaped by the verbal, action and material symbols of the company culture; and (e) company goals and decisions result from this process. One example is the model proposed by Pettigrew and Whipp (1991), which point out five interrelated aspects of managing change, shown in Figure 2.10.
The five central factors are:

- coherence: consistency and feasibility; includes leadership, senior management team integrity, and the management of interrelated change events over time;
- environmental assessment: considers the availability of key people and internal character of the organisation, and involves planning;
- leading change: building a receptive context for change, creating the capability to change and constructing the content and direction of change;
- human resources as assets: use of situational features to create a positive force for HR change, and demonstrate the need for business and people change; and
- linking strategic and operational change: justifying the need, building capacity for appropriate action, and supplying vision, values and business direction.

The political and cultural change approaches do not prescribe a sequential model for change. In contrast, they focus on change as an analytical, educational and political process (Pettigrew, 1985). Such models address the sociological and psychological aspects of change, i.e. the ideas and rationales underlying the change activity.

**Eclectic models of change**

Eclectic approaches to change management are those in which different elements from a range of ‘purist’ change management models are applied together (Lippit et al., 1985). The model presented in Figure 2.11 describes an example of this approach. It is divided into eight sequential steps, which could be used to produce change of in organisations. Accordingly to Kotter, (1996:22):
“The first four steps in the transformation process help defrost a hardened status quo... phases five to seven then introduce many new practices. The last stage grounds the changes in the corporate culture and help make them stick.”

Therefore, the links between this and Lewin’s (1947) model are clear. The model is further developed in Kotter and Cohen (2002), with a stronger focus on changing people’s behaviour, which the authors regard as being the core of change efforts.

**Figure 2.11: Example of an eclectic model for change (Kotter, 1996)**

**BPR implementation models**

Several conceptual implementation models and methodologies can be found in the BPR literature. Examples of such models are: (a) Peppard and Rowland (1995), which focuses on processes, people and technology; (b) Sengal and Farzaneh (1996), presenting a framework for implementing TQM or BPR; (c) Yung (1997), integrating process and organisational reengineering; (d) Fowler (1998), presenting an implementation framework based on operations management, systems thinking and organisational learning principles; (e) Vakola et al. (2000), focusing on BPR and IT implementation within the construction industry; and (f) Tissari and Heikkila (2001), linking BPR and organisational learning. Even though such methodologies have been
developed with different focuses, consensus has emerged and some common themes can be identified.

The first common theme is that such methodologies are one-off type models, i.e. they have a defined start and end. Therefore, they concentrate on creating change rather than managing change as a continuous event (Cooper, 1994; Stickland, 1998). This assumption could prove wrong since competition and market conditions require many companies to effectively manage market, political, technological and environmental changes constantly (Cooper, 1993; Stickland, 1998).

A second common theme is that they provide prescriptive sequential steps to implement changes (Vakola et al., 2000). Initially, the development of a vision, or the definition of strategic goals and targets are described. Then, the models go through the identification and analysis of the processes to be reengineered, followed by process redesign. After that, they describe the need to define a plan, and then pilot and roll-out implementation, followed by an overall evaluation. Most models emphasise the need for creating a team, having an implementation champion, and changing organisational structure. Constructs used to define BPR steps in a range of studies are presented in Table 2.2.

Therefore, BPR models generally support the idea of deterministic projects where plans are to be realised as such (Tissari and Heikkila, 2001). The rational-based idea that change should be implemented in a deterministic sequential manner is present in most of these models. Tissari and Heikkila (2001) also state that usually a missing element is flexibility and readiness to change plans during the reengineering exercise. Stickland (1998) supports this idea, adding that BPR models are based on the identification of patterns within a system, which becomes the basis for the generation of change alternatives, from which a ‘best fit’ decision can be made. As a result, it is believed that there is an optimal or correct change action to pursue.
## Table 2.2: BPR implementation models

<table>
<thead>
<tr>
<th>Proposed stages / steps</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Build a vision / Identify strategic goals, objectives and scope of the project</td>
<td>1 x x x x x x</td>
</tr>
<tr>
<td><strong>2</strong> Recognise/define the problem</td>
<td>x x</td>
</tr>
<tr>
<td><strong>3</strong> Gain management support/ acceptance/ commitment</td>
<td>x x</td>
</tr>
<tr>
<td><strong>4</strong> Formulate a plan / choose a change mechanism</td>
<td>x x x x x</td>
</tr>
<tr>
<td><strong>5</strong> Understand-analyse existing processes / problems and causes / performance gaps / define principles of change / quantify measures</td>
<td>x x x x x x x</td>
</tr>
<tr>
<td><strong>6</strong> Identify/select (core) processes</td>
<td>x x x x x x</td>
</tr>
<tr>
<td><strong>7</strong> Appoint a team / champion responsible for impl. the whole programme</td>
<td>x x x x x</td>
</tr>
<tr>
<td><strong>8</strong> Communicate / win acceptance from employees / disseminate results</td>
<td>x x x x x</td>
</tr>
<tr>
<td><strong>9</strong> Provide training</td>
<td>x</td>
</tr>
<tr>
<td><strong>10</strong> Benchmark</td>
<td>x</td>
</tr>
<tr>
<td><strong>11</strong> Redesign</td>
<td>x x x x x x x</td>
</tr>
<tr>
<td><strong>12</strong> Review people and technological requirements</td>
<td>x</td>
</tr>
<tr>
<td><strong>13</strong> Validate new process and realise temporary measures</td>
<td>x x</td>
</tr>
<tr>
<td><strong>14</strong> Review organisational structure, competences and motivation</td>
<td>x x x x</td>
</tr>
<tr>
<td><strong>15</strong> Define new roles</td>
<td>x</td>
</tr>
<tr>
<td><strong>16</strong> Develop action plans</td>
<td>x</td>
</tr>
<tr>
<td><strong>17</strong> Pilot implementation</td>
<td>x x</td>
</tr>
<tr>
<td><strong>18</strong> Verify if improvement principles are correct</td>
<td>x</td>
</tr>
<tr>
<td><strong>19</strong> Phased implementation roll out throughout the company</td>
<td>x x x x</td>
</tr>
<tr>
<td><strong>20</strong> Monitor performance (indicators)</td>
<td>x x</td>
</tr>
<tr>
<td><strong>21</strong> Assess performance/ evaluate</td>
<td>x x</td>
</tr>
<tr>
<td><strong>22</strong> Identify new uses for the capability developed</td>
<td>x</td>
</tr>
<tr>
<td><strong>23</strong> Stabilise success/ standardise process use and implementation method</td>
<td>x x</td>
</tr>
<tr>
<td><strong>24</strong> Continuous improvement</td>
<td>x x</td>
</tr>
</tbody>
</table>

1 – Peppard and Rowland, 1995  
2 – Sengala and Farzaneh, 1996  
3 – Vakola et al., 2000  
4 – Yung, 1997  
5 – Zinser et al., 1998  
6 – Fowler, 1998  
7 – Tissari and Heikkila, 2001

### Discussion

Models of planned change provide an important foundation for understanding change within organisations. The human resources and eclectic models describe strategies or steps that should be developed to achieve successful change, while the political/cultural models describe the rationale underlying the change process.

BPR models prescribe change steps. Such models are based on the assumption that change is a one-off activity; therefore they concentrate on creating change rather than managing change as a continual event. It could be argued that the climate of continual change within business environments and companies can be eroding the usefulness of such change models, as they were devised for more stable climates.
Furthermore, the potential oversimplification of such change models is a major problem described in the literature (Beer et al., 1993; Cao et al., 2001; Hamlin et al., 2001). In many cases the simplified diagrammatic formats of the models can appear to be just common sense, which can lead to the omission of important steps, and a lack of rigour in the application of such models (Beer et al., 1993; Hamlin et al., 2001). The lack of change expertise on the part of managers, trainers and developers has been pointed out as one of the reasons for these problems.

Lindsay et al. (2003) state that BPR represent a ‘repackage’ of traditional techniques derived from scientific management, which are very mechanistic in nature. The authors also point out that even though attempts have been made to soften such techniques by adding e.g. a team working, shared values type of approach, the models still represent positivistic approaches that should be used to shape and structure human activities. In this way, the literature fails to address the complexity and non-linear nature of much of the work carried out in organisations. It also assumes that humans are rational decision makers cooperating together to achieve agreed and clearly defined goals, and are concerned with past practice and promoting standardised best practice (Lindsay et al. 2003). As demonstrated by Pettigrew and Whipp (1991), companies are composed of individuals and groups which can have differing values, needs and goals, which sometimes leads to conflicts, and this factor is not considered within BPR.

The specific features of the organisation in which a process model is to be implemented will determine the appropriateness of the implementation strategy to be adopted, as well as the way it should be conducted. Formulating an appropriate implementation strategy is critical for success. Such strategy needs to be holistic and applied at all the organisational levels. Support from top management, leadership during the implementation effort and commitment from all parties involved are also critical.

The argument being made is that implementation needs to be understood as an organisational change process, which involves changes at the individual, group and organisational levels (Makin et al., 1996; Stickland, 1998). Individuals need to be motivated to change their behaviour in some way to allow the adoption of a process model (Burnes, 2000). Users need to perceive benefits arising from the PDP model use to effectively engage to the new way of managing the process. Furthermore, different
groups will have different views on the implementation process, which can lead to potentially conflicting actions between such groups (French and Bell, 1995).

It is postulated that an increased understanding of process models implementation could be achieved by critically describing implementation efforts instead of prescribing implementation steps. From this view, the following research questions are posed:

- How do project teams implement PDP models (how the implementation process occur within specific cases)? and
- Is the implementation strategy in specific companies appropriately considering people issues (e.g. consensus, collaboration and motivation) and process issues (e.g. need to change at the three levels, leadership, continuous change)?

### 2.4.7 Research hypothesis drawing from a change management perspective on the implementation of PDP models

The need for an implementation strategy has been largely emphasised. Such strategy would describe issues related not only to the process model design and the improvements to current practices, but also approaches to enable behavioural change, which would allow the posterior routinization of the new practices within the company. It is important that the strategy considers the three change stages of unfreezing current state, moving to the new state and refreezing the new state (Lewin, 1947). The development of the PDP model can be a way to unfreeze the current state, adaptation and adoption of the model are ways of moving from the old to the new state, and the adoption of the model in multiple projects will allow the re-freezing of the proposed changes, as it has been discussed in section 2.3.1.

It is also suggested that there can be considerable variation in the application of process models due to the different ‘forms’ that adaptation can take (Bresnen and Marshall, 2001), i.e. the adaptation of the generic process into the specific process model involves objective issues, such as the project context in which it is to be applied, and also softer issues, such as personal beliefs of the model users. Thus, it is possible to state that defining an implementation strategy is necessary but not sufficient for successful outcomes. Implementation is an interactive process, in which learning occurs
through the participation and motivation of the model users. Hypothesis 4 summarises this thinking:

**H4:** Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP implementation and replication when compared to companies where future users do not participate in the model development.

### 2.4.8 Summary

Organisational change is approached in this research as the conceptual lenses through which the implementation process could be understood and made more effective; i.e. implementation is approached as a change process within organisations.

In this research, the PDP model use is approached as change occurring in the organisation, group and individual levels. Therefore, benefits should be perceived at all levels if success is to be achieved. Besides, implementation will be effective when individual behaviour is modified. In this way, individual beliefs with regards to the model would influence behaviour, and therefore the success of implementation. This also has implications for the formulation and conduction of the implementation strategy, as the need to involve users in the model design becomes evident. Such strategy should consider that implementation require to be managed as a continual event within the organisation, being affected by forces internal and external to the organisation.

The technology transfer literature offers a complementary perspective on the implementation process and its problems, which is presented as follows.

### 2.5 Implementation content: insights from the technology transfer literature

The transfer of PDP model content can be analysed in relation to the conceptual underpinning present in the technology/knowledge transfer literature. Knowledge transfer provides three main insights into understanding implementation. First, the implementation of a PDP model involves the transfer of the knowledge embedded in the model from its developers to its users. Such knowledge needs to be understood and
Chapter 2: Literature review and synthesis

interpreted (i.e. absorbed) by the user, which then will be able to apply it to manage the project in hand. As a result, model users could identify potential benefits (as well as problems) that would accrue from the model use to the organisational, project and individual levels.

Second, the use of a PDP model to manage diverse projects can be analysed as a replication of organisational routines. Replication is a process by which organisations re-utilise knowledge that is already in use providing a vivid example of the idea of leveraging knowledge assets (Winter and Szulansky, 2000). In this way, the re-utilisation of the knowledge embedded in a process model through the different company’s projects can be analysed as a replication issue. This is important because the aim of process model’s implementation is the use of the model not only in one project, but in all different projects developed by the company.

Finally, there are a variety of factors that affect the opportunity to transfer, which can originate from different sources, and are likely to predict difficulties during the transfer. Those factors are referred to as measures of stickiness (Szulanski, 1999). It is postulated that such measures of stickiness could represent barriers influencing the success of the overall implementation effort.

Each of these issues is further described in the following sections. The concepts of technology transfer and knowledge as adopted in this research are presented to ground the theoretical discussion.

2.5.1 Concept of technology transfer adopted in the research

Technology is “any tool or technique, any product or process, any physical equipment or method of doing or making, by which human capability is extended” (Schon, 1967:1). In the operations context, technology is technical knowledge (or ‘know-how’) applied to improve an organisation’s ability to provide products and services (Bohn, 1994). More specifically, a generic model can be approached as a technology aiming at describing and improving the technical knowledge, or know-how of the firm on its PDP.

According to Stock and Tatikonda (2000), the common line among many definitions of technology transfer is the movement of technology from one organisation to another,
that is across the organisational boundary of the source and recipient (referred to as inter-firm transfers). Nonetheless, studies have also focused on the transfer of knowledge within an organisation - intra-firm knowledge transfers (e.g. Malik, 2002), as well as at the project level (e.g. Nobeoka and Cusumano, 1994). Technology transfer implies formalised transfers, but one of its essential elements is developing strategies to encourage spontaneous, informal exchanges (Davenport and Prusak, 1998).

The means to ‘move’ technology within organisations involve two actions: transmission, i.e. sending or presenting knowledge to a potential user or recipient, and absorption of the knowledge by that person or group (Davenport and Prusak, 1998). Consequently, access to knowledge is necessary but by no means sufficient to ensure it will be used. Furthermore, transmission and absorption have no value if the knowledge does not lead to some change in behaviour (see section 2.4), or to the development of some idea that leads to change in behaviour (Davenport and Prusak, 1998).

Technology transfer is approached in this research at the organisational level, i.e. the transfer of knowledge from the generic process model (and its developers as senders) to the specific process model (and its users as recipients). The project level is approached through the replication of the process model use throughout different projects developed by the organisation.

It is also important to define the starting and ending point of a transfer. Similarly to what has been proposed by Stock and Tatikonda (2000), the starting point of technology transfer is here defined as the point in time immediately after the decision to design and implement a new PDP model. The actual utilisation\(^7\) of the technology by the model user is considered as the concluding step of the transfer. The decision to design and implement the PDP model can also be related to the concepts of exploitation and exploration of knowledge. According to March (1991:71):

> “exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes things such as refinement, choice, production, efficiency, selection, implementation, execution. Adaptive systems that engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of experimentation without gaining many of its benefits.”

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\(^7\) Utilisation involves the use of the generic process model within specific projects’ environments.
Therefore, there needs to be a balance between exploitation and exploration within organisations. The design of a process model is an exploration, which includes the search for problems and potential improvements. Using this information, a PDP model is generated, which then is transferred to users. Nonetheless, adaptation is necessary to allow the exploitation and adoption of the knowledge embedded in the generic model.

Thus, for the purposes of this research, technology transfer in PDP implementation involves the appropriate exploration, generation, movement, adaptation and adoption of PDP knowledge within and between organisational units, focusing on enabling organisation development and process improvement. The next section conceptualises knowledge, drawing implications for PDP model implementation.

### 2.5.2 Knowledge

The question of defining knowledge is challenging, and although researchers have been discussing the issues for several hundred years, there is still not a formal definition (Martensson, 2000). The concepts of knowledge, information and data are related, and describing their differences is a usual way of defining knowledge.

Data are discrete, objective and non-contextual facts about events; usually, these facts describe or quantify events (Davenport and Prusak, 1998). Information is data that has been sorted, analysed and displayed, and is communicated through language, graphics or tables (Dixon, 2000). That is, context is added by organising or categorising it with a purpose in mind (Davenport and Prusak, 1998). Knowledge, by contrast, is defined as the meaningful links people make between information and its application in action in a specific setting (Dixon, 2000). Knowledge is a fluid mix of framed experiences, contextual information, interpretation, reflection and perspective (Davenport et al., 1998). Therefore, it is possible to state that there is a high amount of information within a PDP model, which can be transformed into knowledge by the model user through interpretation and reflection.

In the literature, another way to define knowledge is to make explicit the distinction between ‘tacit’ and ‘explicit’ knowledge. As described by Nonaka and Takeuchi (1995):
• explicit knowledge is formal and systematic, documented and public, structured, externalised and conscious; and
• tacit knowledge is not easily visible and expressed; it resides in the human mind, behaviour and perception; it is deeply rooted into individual’s actions and experience, as well as the ideas, values or emotions he/she embraces. Subjective insights, intuitions and hunches fall into this category.

Nonaka and Takeuchi (1995) also suggest that the process of creating knowledge is a spiralling of knowledge acquisition, a product of explicit and tacit knowledge. It starts with people sharing their internal tacit knowledge by socialising with others or by capturing it in some way. Other people then internalise the shared knowledge, and that process creates new knowledge, which is once more shared by social interaction, and new knowledge is created through this cycle.

The differentiation between explicit and tacit knowledge has implications for implementation. It is possible to state that a PDP model, as a written document, presents explicit knowledge about the PDP. This knowledge can be transferred with reasonable accuracy (Davenport and Prusak, 1998). However, product development is a complex process in which there is a large amount of tacit knowledge (Reinertsein, 1995; Ulrich and Eppinger, 2000; Herder et al., 2003). Moreover, there is a big amount of tacit knowledge generated during the PDP model design, and both knowledge types needs to be transferred to the model users to allow successful implementation.

Tacit and ambiguous knowledge is especially hard to transfer from the source that creates it to other parts of the organisation (Davenport and Prusak, 1998; Szulanski, 1999). Tacit knowledge is inherently difficult to transfer because it cannot be fully articulated through written and verbal communication, and thus must be learned through experience (Nelson and Winter, 1982; Nonaka and Takeuchi, 1995; Empson, 2001). Empson (2001) also describes that transferring embedded knowledge is also difficult because it is highly context-specific and resides in an organisation’s interrelated systems of physical, human and organisational capital. Accordingly, the transfer of tacit knowledge requires relationships such as partnerships, mentoring, and others through which explicit and tacit knowledge can be shared.
Furthermore, complex knowledge requires re-construction and adaptation at the receiving end of the transfer (Grant and Gregory, 1997; Bresnen and Marshall, 2001), and many problems can arise during such adaptation, which may involve comparisons of the project specific model as a ‘replica’ to the PDP model as a ‘template’ (Szulanski, 1999).

In summary, the knowledge embedded in a PDP model is often complex and ambiguous, and there is a large amount of tacit knowledge involved in the PDP. The practical application of such knowledge involves transmission, absorption, adaptation and reconstruction by the process model users (see also section 2.4.1).

A PDP model describes (new) routines, which will be replicated through the application of the model to manage different projects. The concept of replication of routines as its implication to PDP models’ implementation is described as follows.

### 2.5.3 Replication of routines

Routine is a term that has been used to refer to all regular and predictable patterns of behaviour in a firm (Nelson and Winter, 1982). Therefore, routines are a persistent feature of an organisation; they are constant patterns of internal activities that determine the organisation’s possible behaviour, since the environment also determines actual behaviour (Nelson and Winter, 1982). Also, they are designed to solve a defined group of various problems through rule-based behaviours (Aguilar-Zambrano, 2001). Routines can be replicated within different parts of companies (Winter and Szulanski, 2000:2):

“replication involves the creation of ‘replicas’ – that is, of a series of local routines that are quite similar to the original routine in significant aspects. At the micro-level, a routine in operation at a particular site can be conceived as web of coordinating relationships connecting specific resources”

It has been postulated that the concept of replication of routines can be useful for understanding implementation. Accordingly, the PDP model represents a series of (new) routines aiming at improving the product development process. Such routines should be replicated through different projects, ideally to all company projects, leading to consistency in process management (see section 2.2.4).
The concepts of transfer and replication as used in this research are described in Figure 2.12. Transfer here involves the effective sharing, movement and transformation (or adaptation) of the tacit and explicit knowledge embedded in the PDP model. The model described in Figure 2.12 represents a somehow linear description of technology transfers and replication, in which the content of the model is transferred from the developers to the users only. In practice, this process can happen in different ways, for instance knowledge can be transferred from the model developers to the users, but also between users during the replication of the process model. Thus, the transfer process have been described as non-linear, complex and dynamic (Dixon, 2000).

![Diagram showing technology transfer from the generic process model to the specific model, and replication throughout different company’s projects.]

Technology transfers should be approached as a process, and not an act, to make possible the analysis of the difficulties often related to it (Szulansky, 1999). The author further describes four stages in a transfer: initiation, implementation, ramp up and integration. Initiation involves the decision to transfer, and thus is related to the model design. The initial implementation effort is composed by ‘learning before doing’ (Pisano, 1996), which can occur by planning or by experimenting (through pilots) before knowledge is actually put in use by the recipient. Then, there is ‘learning by doing’ in the ramp up, which entails the resolution of unexpected problems that arise when knowledge is put to use. Integration involves the gradual routinization (or replication) of the new knowledge, after satisfactory results are obtained.
In order to understand difficulties in the analysis of intra-firm knowledge transfers, Szulanski (1999) developed a set of measures of stickiness for each stage of the transfer. Those measures are described in the next section as they provide insights into factors that can create difficulties during implementation, demonstrating potential barriers.

### 2.5.4 Stickiness of knowledge transfer: implementation barriers

The implementation of a process model is a multi-faceted phenomenon, being often laborious, time consuming and difficult (Mill and Ion, 1994; Bessant and Francis, 1997; Cooper, 2001; Jones and Pitts, 2003). Therefore, myriad factors can contribute or hinder the effective use of process models in real life settings (Pugh, 1991; Mill and Ion, 1994; Cooper, 2001). It is acknowledged that such factors are company specific, but it is important to provide a framework by which they could be proactively identified and managed throughout implementation efforts.

In a difficult technology transfer problems are likely to multiply (Szulanski, 1999), as they also do in difficult implementation efforts. Some problems will be diagnosed and resolved easily by those involved with the implementation (e.g. via contingency plans), but not all problems will. The diagnosis and resolution of problems may transcend the resources of the actor that is affected by them; therefore it is likely to require action from different managerial layers in the form of different resources being made available (Szulanski, 1999; Empson, 2001).

Furthermore, such problems will be noticed because they disrupt the flow of events during implementation. The level of implementation difficulty is likely to reflect the number and intensity of those distinct moments of difficulty. These moments of difficulties are referred to as stickiness of knowledge transfer (Szulanski, 1999). It is proposed in this research that such measures of stickiness can be used to identify difficulties in PDP models’ implementation effort.

The level of complexity of the PDP model content can generate difficulties during implementation (see section 2.3.1). It is postulated that the more complex the model content is, the more likely that problems will arise due to difficulties in adapting it, as represented in Figure 2.14. Such difficulty relates to the ambiguity generated due to the complexity or depth of the practice to be implemented, referred to as causal ambiguity.
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(Szulanski, 1999). Causal ambiguity can generate uncertainty in proceeding with implementation, and it can occur due to: (a) the model developers’ understanding and ability to explain the PDP model content can be incomplete; and (b) the model users’ ability to specify the environment in which the model will be applied can also be incomplete (Nonaka and Takeuchi, 1995; Szulanski, 1999).

![Diagram: Process model complexity and its effect over the likelihood of implementation problems.](image)

**Figure 2.13: Process model complexity and its effect over the likelihood of implementation problems.**

If the knowledge embedded in a process model is not considered robust, i.e. if there is a certain degree of conjecture on the utility of the model (Szulanski, 1999; Dixson, 2000), it can be assumed that it is likely that users will not apply it. This creates second type of stickiness, i.e. unproven knowledge. Assessing a PDP model robustness involves the consideration of issues such as the existence of solid proof that the model is really helpful and that it contributes to management. Such solid proof could be provided by performance measures or through the validation of the process model through successful pilot implementations.

The ease of communications, collaboration and intimacy of the relationship between the PDP model designer and its users also affects implementation. In cases where there is a laborious and distant relationship (i.e. an arduous relationship), problems will arise in implementation due to the difficulties in transferring the tacit knowledge related to the process model (Szulanski, 1999). Empson (2001) further supports this idea, stating that barriers to transferring tacit knowledge could reflect barriers to inter-personal communications, which can in turn disrupt implementation.
The motivation of the model developer to implement can also provide difficulties (see section 2.4.3). The motivation of the model developer (or source) may vary with the incentive to compete or collaborate with the users (recipients) and with the effort required to support the transfer, as well as with the existence of rewards (Davenport and Prusak, 1998; Teece et al., 1997). Supporting implementation disrupts the normal activities of the model developer, especially when it means generating documents or training personnel (Szulanski, 1999).

As it happens with model developers, the model users may also lack motivation. Implementation will disrupt the users operations not only with regards to the new working practices being introduced, but also in terms of personnel being retrained or reassigned, as well as infrastructure being modified. Lack of motivation may result in foot dragging, passivity, feigned acceptance, hidden sabotage, or outright rejection in implementation (Szulanski, 1999).

It has been argued that a capable and trustworthy process model developer is more likely to influence the behaviour of the recipient (Szulanski, 1999). Therefore, the degree to which the model user perceives the model developers and the sources of information used to design the model as reliable can generate implementation difficulties.

A further potential source of problems is related to the lack of absorptive capacity of the model users, i.e. their ability to exploit outside sources of knowledge. Users can have difficulties in their ability to identify, value and apply new knowledge, which is largely a function of the organisation’s prior related knowledge (Cohen and Levinthal, 1990). Also, as described in section 2.3, the challenges of abandoning old ways of doing things and preserving new ones could be significant.

Finally, the organisational context may affect the willingness and ability of organisational sub-units to complete implementation tasks. The influences can occur through norm and value settings, through incentives and through counselling and support (Szulanski, 1999). In such way, in a barren organisational context implementation successes can be difficult (Szulanski, 1999; Empson, 2001).
In summary, the stickiness of knowledge transfer can be applied to identify measures of implementation stickiness, which are: (a) causal ambiguity; (b) unproven knowledge; (c) arduous relationship; (d) model developers lack motivation; (e) model users lack motivation; (f) model developer is not perceived as reliable; (g) model user lacks absorptive capacity; and (g) barren organisational context. Such measures of stickiness may provide a typology for implementation barriers.

The suitability of these measures to describe problems or barriers that occur during PDP model implementation needs to be addressed. It is postulated that if drivers, enablers and barriers to implementation are identified and managed as part of the overall implementation strategy, there will be better opportunities for achieving implementation success. In this way, a research question has been proposed:

- What are the factors influencing the success or failure of the implementation of PDP models in practice?

### 2.5.5 Research hypotheses drawing from a technology transfer perspective on the implementation of PDP models

Davenport and Prusak (1998) stated that the goal of an organisation in transferring knowledge is to improve its ability to do things and therefore increase its value. Transferring knowledge through a PDP model is therefore a means to improve an organisations ability to execute and manage product development activities. Originating from this thinking, a new perspective on the conceptual framework of this research was developed, as shown in Figure 2.14.

Accordingly, through the PDP model design, new knowledge is generated. This needs to be transferred from the model developers to its users. The absorption of the knowledge embedded in the generic model will occur through people sharing tacit and explicit knowledge about the model, which will allow for its adaptation into a specific process model. Finally, knowledge will be used through the specific model to change the project team behaviour, resulting in the introduction of improvements to the process. From this approach into the theoretical framework of the research, research hypothesis 5 is proposed:
**H5**: Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy.

It is assumed that one reason for the problems encountered by construction companies in implementing generic PDP models is that the knowledge embedded into those models is not successfully transferred from developers to users by training and by social interactions. Instead of providing means to allow explicit and tacit knowledge to be transferred to the model users, companies hand in documents (the model) to users, thus transferring only explicit knowledge. This will have implications for the implementation success, since it is difficult for the user to capture and absorb the complex knowledge embedded into the model, and the tacit knowledge created during the model development is not available. Therefore, it is believed that there will be companies in which process models are designed and publicised through manuals, but the knowledge described in those models is not applied in practice due to the lack of means to effectively transfer this knowledge. Therefore, it is necessary to understand the deeper
underlying assumptions about knowledge and its application prior to the use of such models in practice.

With regards to the replication of knowledge throughout different projects, i.e. the routinization of the process model within the company, the following hypothesis is postulated:

**H6:** Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects than companies in which the generic model is not continuously and explicitly updated.

The importance of updating the PDP model knowledge content based on specific experiences on its application has been largely discussed in the literature (e.g. Kagioglou, 1998; Vakola et al., 2000; Cooper, 2001; CRISP, 2001; Herder et al., 2003). Therefore, the importance of keeping the knowledge bases updated is clear.

Hypothesis 6 postulates that replication will occur more effectively in companies in which such updating occurs since: (a) it demonstrates that the model has been validated; (b) it provides evidence that the model is helpful, and that it contributes to the company’s competitive advantage; (c) it demonstrates that using the model is important within the organisational context; and, therefore (d) it can motivate model users.

### 2.6 Linking knowledge areas through questions identified in the implementation concept model

The literature related to the implementation of PDP models has been structured around a model, set out in Figure 1.1, describing implementation though its triggers and outcomes, strategy (steps), and the transfer of the process model content. Process management research provides valuable insights on the benefits and possible outcomes from applying process models in practice, but focus is given to process model design, and implementation issues are scarcely described.

The implementation of a process model occurs through a set of steps or activities that need to be defined at the organisational level and conducted at its tactical and
operational levels. Much of the literature on process models implementation presents generic guidelines and prescriptive models, which generally approach change as a one-off activity, and do not consider that it should be managed as a continuous event within organisations. Empirical results have suggested that the use of such frameworks has been leading to outcomes which were not as successful as expected. Organisational change literature offers the unfreeze, move and refreeze model, which provides a fruitful platform to better understand and therefore enact implementation as a change process within construction organisations. Nonetheless, the need to appropriately link the implementation strategy to the organisational context and to soft people issues (such as consensus, collaboration and motivation) has not been sufficiently addressed.

The importance of explicitly assessing the usefulness of the model content in the organisation and project levels has also not been sufficiently emphasised in the literature. It appears that it has been assumed that any change or innovation proposed in such models would be beneficial, regardless of the type of organisation and project to which it is being applied. As a consequence, the literature does not explicitly describe means to assess such usefulness.

The technology transfer literature offers a complementary perspective on the implementation process by looking at the transfer of information within and across implementation steps. It also provides a framework to identify potential problems that can occur in implementation efforts. Such implementation difficulties (or stickiness) related to transferring the knowledge content of the model throughout the organisation and between different projects are yet to be established.

Based on the findings of this literature synthesis, it is possible to state that the knowledge on process models implementation is characterised by a lack of clear direction. Several gaps in the understanding of PDP models implementation in construction are identified, and such gaps hinder our understanding of this multifaceted phenomenon. Such gaps are described in Figure 2.15. Whilst our understanding of implementation is not increased, it is envisaged that companies will continue having difficulties in achieving the espoused benefits of designing and adopting process models.
The research questions identified in Figure 2.15 are addressed in this research through the discussion of the research hypotheses, which are linked to each question. Additional information tackling research questions is presented in the descriptions of the implementation triggers, outcomes, process and content within each case study, described in chapters 4 and 5.

2.7 Summary

This chapter discussed the relevant literature for this research. First, insights from process management were presented, describing efforts into process modelling, the benefits of process models as the main drivers for implementation, as well as the reported implementation outcomes. Second, insights from the change management literature were presented, describing the need for planning implementation, levels at which change occurs, as well as implementation problems. Finally, it discussed implementation as the transfer of the knowledge embedded into a PDP model from developers to users, and difficulties during transfers were presented to provide a framework to understand implementation barriers.

The following chapter presents and analyses the methodology used for this research.
3 Research Method

3.1 Introduction

The previous chapter set out the research domain and described the research questions and hypotheses. This chapter concentrates on the design, development and execution of the research method used to test these hypotheses and, in doing so, create new theoretical insights. The chapter describes the research methodology, research philosophy, strategy, the techniques applied and the validation aspects of the method.

The basic purpose of research is theory, i.e. to understand and explain phenomena, gaining solutions to problems or answers to unsolved questions. A theory presents a systemic view of phenomena by specifying relations among variables, with the purpose of explaining or predicting (Kerlinger, 1979). Research methodology represents the logic of development of the research process used to generate theory (Kerlinger, 1979). Therefore, it refers to the procedural framework within which the research is conducted (Remenyi et al., 1998). Good quality research should be rigorous, systematic, integrated and focused (Peters and Howard, 2001:595):

'[good research is] research that meets the criteria of rigour, a systematic kind of modelling in its articulation and which ties back its processes to a solid grounding in what we know about the area … being researched, so that there is a total integration of varying viewpoints in the grounding of the research design'.

In order to make that possible, a ‘nested’ research approach was adopted for the design and development of this research. The next section discusses the nature of this methodology and the rationale for its adoption.

3.2 Research method: nested approach

Different methodologies can be used to design and execute research. Nonetheless, the method used should be suitable to develop and test theory within the area being studied (Kerlinger, 1979; Remeyi et al., 1998). In order to choose a correct method, sensible decisions have to be made considering the purpose of the study, the questions being investigated, and the resources available (Robson, 2002). Product development process models implementation is a complex phenomenon very much shaped by the organisational context in which it takes place, as well as by the perspectives, beliefs and
motivations of the individuals involved (see chapter 2). Thus, the research method applied should be appropriate to help understanding the complexities of the implementation process within context specific settings, as well as the myriad factors that affect it.

Understanding the elements that constitute a methodology can assist in reaching appropriate alignment between the method and the study area. Those elements include the research philosophy, approach\(^8\) and techniques. A research philosophy guides and unifies the research strategy and techniques. A research approach consists of the dominant theory generation and testing methods, i.e. the approach taken towards the data collection and analysis so that information can be obtained from the data, whilst the research techniques comprise mainly data collection and analysis tools.

The ‘nested’ approach described by Kagioglou et al. (1998) and Sexton (2000) provides a holistic, integrated research method, generating a framework that “provides the researcher with a research approach and techniques that benefit from epistemological level direction and cohesion” (Sexton, 2000:76). The application of the nested approach to this research is shown in Figure 3.1 and further described in the following sections.

\(^8\) Research approach is also referred to in the literature as research strategy (Jankowicz, 2000) or research method (Yin, 1994).
3.3 Research philosophy: hermeneutic learning spiral

All scientific research aims at generating theory. Epistemology is “the theory or science of the method or grounds of knowledge” (Blaikie, 1993:6). Therefore, it refers to the assumptions made about the ways in which it is possible to gain knowledge about reality, presenting a view and justification for what can be regarded as knowledge (Easterby-Smith et al., 2002).

There are two main schools of thought that have been shaping the epistemological debate on how to best conduct research, describing different and competing inquiry paradigms. Positivism refers to “all approaches to science that consider scientific knowledge to be obtained only from sense data that can be directly experienced and verified between different observers” (Susman and Evered, 1978:583), including rigorous observations to generate scientific knowledge. In this way, it mainly uses quantitative and experimental methods to test hypothetical-deductive generalisations (Blaikie, 1993). Positivism searches for causal explanations and fundamental laws, and usually reduces the whole to the simplest elements in order to facilitate analysis (Easterby-Smith et al., 2002; Remenyi et al., 1998).

On the other hand, interpretative9 social science is more concerned with observation and description, generating hypotheses (Silverman, 1998). As pointed out by Miles and Huberman (1994), human activity is seen in interpretivism as ‘text’, i.e. a collection of symbols expressing layers of meaning, and research is concerned with a deep understanding of such meanings. This type of enquiry uses mainly qualitative approaches to understand and explain a phenomenon (Easterby-Smith et al., 2002). Furthermore, it recognises the individual viewpoints of practitioners and researchers involved in the process (Seymour, 1997).

Critiques have been presented to both inquiry paradigms within construction management research. On one hand, phenomenological research has been questioned by the argument that through the ‘inductivist’10 approach it is not possible to create generalisable theory as two individuals observing the same phenomena could reach

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9 Also referred to as phenomenology; it concerns phenomena, i.e. our experience of things. In this way, phenomenological methodology seeks to understand another’s experience (Cohen et al., 2000).
10 The author states that this approach is related to observing the natural world and deriving theories on what we see, therefore it can be related to phenomenology
different conclusions due to their different preconceived notions and background beliefs (Harriss, 1998). On the other hand, Seymour et al (1997) critiques the use of positivist approaches in the area of built environment management, stating that it is important to have a greater proximity between researcher and real life problems. Susman and Evered, (1978:583) presented a similar critique to the positivist model applied to organisational research:

“By limiting its methods to what it claims is value-free, logical and empirical, the positivist model of science when applied to organizations produces a knowledge that may only inadvertently serve and sometimes undermine the values of organizational members.”

The aim of this research points to the development of a study in an organisational context, close to the real world, as it includes the implementation of PDP models within companies as a central element of the investigation. As a consequence, the epistemological option for this research is based on the interpretative school of thought. The research uses qualitative approaches to inductively and holistically understand human experience in context specific settings. As pointed out by Silverman (1998:3, emphasis in original), a “particular strength of qualitative research … is its ability to focus on actual practice in situ, looking at how organisations are routinely enacted.” The researcher thus analysed the implementation process with an emphasis on the meanings, facts and words to reach a broader understanding of the phenomena.

The implementation of PDP models involves changes in the behaviour of individuals within organisations, and such a research problem cannot be properly addressed through the expected objectivity in data collection and analysis of the positivist paradigm. As stated by Schon, (1999) there is a dilemma of rigor or relevance that is faced by researchers, in which one can solve relatively unimportant problems accordingly to the standards of rigor, or try and solve more important problems where one cannot be so rigorous because problems are messy and confusing. Susman and Evered (1978) further describe that one of the causes of lack of relevance on organisational research is related to the adoption of positivist approaches, which focus attention to rigour. This research sought to achieve approximate answers to relevant questions, as opposed to exact answers to relatively unimportant or badly formulated questions (as supported by Holsti, 1969).
In summary, the research focus into understanding the implementation of PDP models within construction companies and on the context-specific factors that affect implementation indicates that an interpretative approach is appropriate for this research area.

Within the interpretative epistemology, this research was rooted on the pre-understanding-understanding hermeneutic spiral\(^{11}\). Hermeneutics originally referred to the art of interpreting texts, in a search for the original, undistorted message of written sources, mainly biblical, judicial and historical (Gadamer, 1976; Bauman, 1978). Contemporary references to hermeneutics focus on its role in interpretation of meaning, the retrieval of purpose, of intention, of the unique configuration of thoughts and feelings which precede social phenomena, as well as its explanation (Bauman, 1978).

The idea behind the hermeneutics spiral is that no knowledge is possible without presuppositions; i.e. the framing of any scientific question assumes some foreknowledge of what we want to know (Susman and Evered, 1978). Understanding therefore means going in circles, as it consists of recapitulations and reassessment of collective memories (Bauman, 1978). In this way, the researcher’s presuppositions are used in an attempt to reach an initial holistic understanding of a social system, and then this understanding is used as a basis for interpretation of the parts of the system (Susman and Evered, 1978).

In this study, research is approached as an iterative process in which the researcher’s \textit{a priori} knowledge, insights and experience form a \textit{pre-understanding} of the research area. This pre-understanding is the basis for searching into the literature on the subject area, which will in turn create a new \textit{understanding} of the phenomenon being studied. This new understanding will then be used to guide empirical research, which will again generate a new understanding of the phenomenon. Understanding is generated not only through the stages of research but also by proceeding from the whole into its parts and then back again. The spiral is represented in Figure 3.2.

\(^{11}\) The term circle is most commonly found in the literature (e.g. Bauman, 1978), but the term spiral is used here because it makes more explicit the open-ended nature of the circle described in the literature.
The hermeneutic spiral provided the researcher with means for understanding her perceptions more clearly, as well as those held by the members of the organisations involved in the study. This in turn made it possible to reach a greater understanding of implementation by considering the different viewpoints of the individuals involved in it.

In summary, it provides a progressive understanding of the implementation phenomena through different viewpoints and by an iterative process of looking to the whole and its parts. It is therefore considered appropriate for this research area.

The research approach that is described in the next section was developed through series of empirical studies that were followed by a redesign of the research questions (see section 3.7.1). This occurred as a consequence of the new understanding of the problem achieved through literature review and empirical studies, and also with a view to identify an inquiry focus which could contribute to the existing understanding within the area of implementation. As the research question pointed to the need for understanding how implementation occurs in specific contexts, a case study approach was taken, which is described in the following section.

### 3.4 Research approach: case studies

A research approach is a way of describing how a researcher goes about the task of doing research, unfolding a particular style and employing different methods. The
choice of an appropriate research approach should be determined on the basis of (Yin, 1994):

- the nature of the enquiry and the type of question being posed;
- the extent of the investigator’s control over actual behavioural events; and
- the degree of focus on contemporary events.

The research approach includes the types of evidence to be collected and the sources of such evidence, as well as the process of interpretation used to obtain satisfactory answers for the questions being posed (Easterby-Smith et al., 2002). Different issues have been considered in determining the most appropriate approach to satisfy the research aims and objectives, as follows:

- the focus of the research on contemporary events with little control over the variables under analysis;
- the aim to answer ‘how’ and ‘what’ type of questions;
- the need for rich primary data to allow understanding of implementation, as well as the scope, sensitivity and nature of the data required to allow testing hypotheses;
- the need to observe the outcomes and effects of process models’ implementation over time; as it requires a considerable amount of time; and
- the author’s personal experience and knowledge.

These issues provide the justification for the selection of the case study approach for the purpose of learning about the process models being developed within companies, understanding the implementation process within its context and capturing the factors affecting its success. Yin (1994:13) defines case study as:

> “an empirical inquiry that
  * investigates a contemporary phenomenon within its real-life context, especially when
  * the boundaries between phenomenon and context are not clearly evident”.

As Gummesson (2000) points out, the aim of case studies is to reach a fundamental understanding of structure, process and people. Thus, case studies may attempt to discover new hypotheses or to test existing hypotheses, ranging from single to multiple
cases, being purely qualitative or combined qualitative and quantitative (Yin, 1994; Silverman, 1998).

The dynamics of implementation were studied in their natural settings by investigating four large companies from the construction and manufacturing industries. The design has been termed by Yin (1994) ‘embedded multiple case’ design. Embedded design denotes different units of analysis. This research was conducted at three levels: (a) the firm (the implementation strategy at the firm level, at all companies studied); (b) the process model (its contents, how it was developed and how users perceived it, at all companies); and (c) the project (implementation at the project level, only at companies A and D). While an embedded design is complex, it provides greater richness and multiple perspectives in explaining behaviour (Bourgeois and Eisenhardt, 1988).

The reasons this research adopted multiple case studies is that they allow the analysis of data across companies, which in turn enables the identification of context specific constraints in the implementation process and outcomes. As pointed out by Miles and Huberman (1994), multiple cases, adequately sampled, provide understanding and explanation, as they help point out specific conditions under which a finding will occur, and also help to form more general categories of how these conditions may be related. In this way, a multiple case design allows for a replication logic, in which each case study serves to confirm or disconfirm inferences drawn from previous ones (Yin, 1994).

In summary, the use of case studies were considered appropriate to this research problem as they provide grounds for investigating implementation in its real-life context. The selection of the cases has a fundamental influence on the outputs of the research, therefore the reasons for selecting the specific cases are outlined in the following section.

### 3.5 Selection of the cases

In the literature, there is no consensus on what would be an appropriate number of cases to be developed when adopting a multiple case study approach. Eisenhardt (1989) recommends that the number of cases should be between four and ten, while Yin (1994)
states that it should be a reflection of the number of literal or theoretical\textsuperscript{12} replications that the researcher would like to have in the study. Therefore, the decision on the number of studies is intuitive and depends on what new information or insights can result from studying further cases (Dyer et al., 1991). In this research, theoretical sampling was applied (Yin, 1994). The focus on large companies sets out the domain of the findings. The initial idea was to analyse polar opposite types, i.e. companies in which implementation has been successful and companies in which it has been unsuccessful. Nonetheless, only the out-of-industry study presented a successful implementation case, thus most of the findings relate to unsuccessful cases.

Four cases were undertaken, three preliminary cases on the first stage of the research, and one main case on its second stage\textsuperscript{13}. The three preliminary case studies are described as companies A, B and C. Company A is a manufacturing company, the only out-of-industry study of this research. It was selected due to the fact that it has been successfully using a PDP model to manage its projects for more than ten years. In this way, it provided rich evidence on the implementation process over a long period of time. An out-of-industry study was developed as many key process improvement principles come from manufacturing (see section 2.2.2). Company B was selected as it had designed and attempted to implement a process model. Company C was selected as they had finalised the design of a PDP model, and were about to implement it. Therefore, it provided evidence on the front-end of the implementation.

The case selected for the second research stage (main, in depth case study) was Company D, in which a design management process model was being developed and was about to be implemented as part of a company-wide improvement programme. Company D provided a rich opportunity for the researcher to examine the design and implementation of a process model in real time.

Multiple sources of evidence were used within each of the cases to allow for triangulation of data (see section 3.9). Such evidence was collected through different research techniques, which are described in the next section.

\textsuperscript{12} Literal replication relates to choosing cases predicting similar results, whereas theoretical replication relates to choosing cases seeking to get contrasting results for predictable reasons (Yin, 1994).

\textsuperscript{13} The stages of this research are described in section 3.7.
3.6 Research techniques

Six techniques have been used at different stages of the research to collect and analyse qualitative data: literature review and synthesis; semi-structured interviews; documentary analysis; observations; content analysis; and cognitive mapping, described as follows. Content analysis and cognitive mapping are described in section 3.7.2 as they are data analysis techniques.

3.6.1 Literature review and synthesis

The preliminary stages of a research project involve the review of the literature pertinent to the topic under analysis. Literature is reviewed at the outset and also throughout the work, during the systematic development of conceptual analysis (Jankowicz, 2000). The same author states that the literature review provides a description and critical analysis of the current state of knowledge in the subject area. Furthermore, it justifies any new research through a coherent critique of what has gone before and demonstrates why the research is both timely and important (Gill and Johnson, 2002). A broad review of primary and secondary\textsuperscript{14} sources of data was carried out in this research. The aim was to:

- provide the researcher with the opportunity to discover what was already known about the subject area; and
- allow the researcher to build on previous experiences of both academics and practitioners.

The areas in which literature was reviewed are described in section 3.7.1.

3.6.2 Semi structured interviews

The most fundamental of all qualitative methods is that of in-depth interviewing (Easterby-Smith et al., 2002). Its importance relies on the fact that the approach potentially provides a rich account of the interviewee’s experiences, knowledge, ideas and impressions, which can be documented (Alvesson, 2003). Burgess (1982) states that

\textsuperscript{14} Primary data is collected by the researcher from the research subjects through questionnaires, interviews, etc; while secondary data is data that was re-analysed by other researchers, and it includes published books, reports, journals, and conference proceedings (Remenyi et al., 1998).
interviews provide an opportunity for the researcher to uncover new clues, opening up new dimensions of a problem, through accounts based on personal experiences.

The term ‘qualitative interview’ has been used to describe a broad range of interview types, varying from those which are totally open-ended in nature, to the ones in which the researcher set more structured questions, along the lines of a formal survey (Yin, 1994; Easterby-Smith et al., 2002). In this research, a semi-structured interview approach was adopted.

As pointed out by Robson (2002), semi structured interviews have predetermined questions, but the order of the questions can be modified based upon the interviewers perception of what seems most appropriate. In this way, they allow the interview to have a general purpose and focus, but are sufficiently flexible to explore emerging issues. As the interviews executed in this research had an exploratory and explanatory nature, this was considered to be the most appropriate approach to be used, as it gave a focus to the interview, allowing the researcher the flexibility to explore emerging issues.

Easterby-Smith et al. (2002), argue that although interviews are claimed to be the best method of gathering information, its complexities are sometimes underestimated. Alvesson (2003:31) supports this idea, arguing that the interview situation should be seen as a “socially, linguistically, and subjectively rich situation”. Yin (1994:80) has described the main weaknesses of interviews: (a) bias due to poorly constructed questions; (b) response bias; (c) inaccuracies due to poor recall; (d) reflexivity (the interviewee gives what the interviewer wants to hear).

A strategy was used to reduce the effects of these weaknesses which consisted of tape recording and verbatim transcribing all interviews, along with complementary data gathering methods. Tape recording avoided the issue of poorly recalling data, and allowed for cognitive analysis to be conducted. An example of an interview transcript is given in Appendix B.

### 3.6.3 Documentary evidence

Yin (1994) suggests that documentary information is likely to be important in any case study. Documents are primarily used to identify new evidence and augment evidence
from other sources, thus providing new insights. The main advantages of using documentation as a source of evidence relies on the fact that it is stable, i.e. it can be reviewed repeatedly, it is unobtrusive and normally provides a broad coverage, i.e. a long span of time, events and settings (Yin, 1994).

In this research, documents were used mainly to provide specific details on the process models being designed within the companies, as well as the implementation steps. Documents also provided complementary information on the organisational structure and common practices on product development management. Documents of diverse types have been collected and analysed, including written reports on the process model and implementation related events, internal e-mails, as well as published information about the companies on the Internet. The specific documentation analysed within each case is described in Appendix C.

3.6.4 Direct observation

Fundamentally different approaches can be used for an observational method of enquiry. These range from two extreme types, i.e. participant observation and structured observation (Robson, 2002). Structured observation is a quantitative style that has been used in diverse disciplines, while participant observation is widely used in flexible, qualitative designs. As this research adopts a qualitative approach, participant observation has been adopted. Therefore, relevant behaviour and context specific environmental conditions, such as company culture, were observed (Remenyi et al., 1998, Yin, 1994).

In this research observation was done only at the main, in depth case study. Participant observation is different from action research: the former is less intrusive, while the latter involves the active participation of the researcher to create change on the subject being analysed (e.g. in a company). Such action research driver happens through interventions into the functioning of the real-world, and it should be done together with the close examination of the effects of such an intervention (Remenyi et al., 1998). This research focused on understanding phenomena but it did not involved creating change through interventions in the case study companies. Participant observation occurred through the attendance of the researcher in meetings of three types: the process model design; the definition of the implementation strategy; and, design management meetings.
The first type included discussions on the model design involving model designer, model users and those responsible for the improvement programme (six in total). The second focused on the implementation strategy formulation / agreement with members from different business areas and regions of the company (one workshop). The final type was design management meetings involving company staff and external designers, which were part of a project in which the process model was to be pilot implemented (four in total). The aim of observing such meetings was to collect evidence on the way the process model was adapted and adopted to guide the specific project development. The project was a PFI\textsuperscript{15} at its 2\textsuperscript{nd} stage in which an extension of a hospital in London was proposed. During this observation, the following issues were analysed:

- how effective was implementation;
- which tools the company used to support implementation, and why;
- which factors affected the design managers’ decision-making concerning the model use; and
- which were the main barriers to the model use at the project.

The next section describes the main steps developed in data gathering, demonstrating when and where each research technique has been applied. Furthermore, it describes the rationale for having two different sets of empirical data collection.

### 3.7 Data gathering and analysis

#### 3.7.1 Data gathering

Figure 3.3 shows the steps developed throughout this research\textsuperscript{16}. Each column in the figure represents a major stage of the research. Each stage represents a pre-understanding / understanding cycle in which the researcher learned about the area being investigated. The stages started with research questions and a major assumption based on the literature as well as on \textit{a priori} knowledge of the researcher, and ended with the critical analysis and reflection on the main outcomes of the empirical results achieved. At the end of the first stage, this critical analysis demonstrated the need for

\textsuperscript{15} PFI: Private Finance Initiative  
\textsuperscript{16} The framework used to present the stages of the research has been based on Hirota (2001)
reviewing further literature, which lead to a better understanding of the problem, a reformulation of the research questions and, as a consequence, a new stage of the research.

The first stage of the research was exploratory in nature, and aimed at identifying and better understanding issues related to process models’ implementation. It started with the following research question: ‘How to support process models implementation in construction firms to allow the achievement of successful results?’

![Figure 3.3: Steps of the research process](image-url)

**Research Problem**: process models impl. in constr. is difficult as such models do not appropriately accommodate the unique characteristics of the project context

**Research Question**: How to support process models implementation in construction to achieve successful results?

**Assumption**: Support can be provided through the development of a framework (process & guidelines) to design and implement PDP models in construction

**Theoretical references**: •Process models in construction; •Design process management; •Process models in manufacturing; •Lean Construction

**Empirical study**: Exploratory cases in: 1 manufacturing company 2 construction companies

**Reflections**: Soft issues are essential to success; impl. process needs to be understood in context; a model to prescribe impl. is not enough to increase understanding and achieve success

**Redesign of the research questions and hypotheses**: Redesign of the research questions and hypotheses

**Outcome**: contribute to the understanding of PDP models implementation in construction firms
The major assumption at this stage was that PDP models’ implementation success levels could be increased through the design of a framework describing steps and guidelines to support implementation. The study, at this stage, was based on a literature review in the areas of process management and process modelling in construction and manufacturing, as well as on concepts and principles described by lean production/ construction. This review clearly demonstrated the main drivers for using PDP models, as well as the potential benefits of applying them within companies. It also demonstrated the need for the better understanding of implementation.

Exploratory case studies were then developed with three companies that have attempted to adopt PDP models. In each firm, the process model, its implementation process and factors affecting it positively and negatively were identified through documents and on intensive interviews (three in the manufacturing and one in each construction company). The questions concentrated on facts and events rather than on respondent’s interpretations. The results pointed out to the need for understanding implementation as a change process and to the importance of considering soft human issues.

These findings directed a new literature review on the areas of organisational change management, business process reengineering and knowledge transfer. By analysing preliminary empirical results and the aforementioned literature areas, a shift in the focus of the research took place. It was realised that frameworks for implementing processes were available in the literature (see section 2.4), and the results of their application were not promising. Also, it became clear that context specific issues affect success, and that the appropriateness of the implementation strategy would be dependent on how it fits the organisational context. The research focus then changed from developing an implementation framework to achieving a better understanding of the design and implementation of process models, considering the myriad issues that affect it. New research questions were proposed:

- What are the improvements to current practices brought about by process models devised/implemented in construction firms?
- Are the espoused benefits of process models achieved in practice? And if not, why are process model implementation efforts often unsuccessful in practice?
- How do project teams implement PDP models? and
• What are the factors influencing the success or failure of the implementation of PDP models in practice?

To answer the new research questions, one in depth case study was developed. The main assumption was that a richer understanding of implementation could be achieved by critically describing implementation as well as the factors affecting it. The aim of the in-depth study was to provide detailed information on the implementation process and factors affecting it by analysing a real effort as it happened. The new research questions have been addressed through the discussion of the research hypotheses using the data from both exploratory and main case studies.

In the main case study, qualitative data was collected over a period of seven months through four semi-structured interviews, documentary analysis and a number of informal meetings in which the researcher took part as an observer-researcher (Remenyi et al., 1998). The interviews were developed in a vertical form, involving different organisational levels (i.e. responsible for the improvement programme, process model developer, design manager and quality assurance manager). Those responsible for the improvement initiative and two design managers were the main contacts of the researcher within the company.

The data collected in both exploratory and main cases included the reasons why the companies decided to invest in designing and implementing a process model, as well as the main goals and expected benefits from the model use. The implementation strategy formulation, modelling methodology applied, the content of the models and activities developed towards implementation were identified. A framework to evaluate PDP model content with a view to its implementation has been devised based on the literature and tested at Company A, the only successful implementation case of this research (see section 4.2.3). The framework was used to evaluate the models developed for companies B, C and D.

Therefore, this research was descriptive, in that it aimed to establish the activities that occur during implementation as well as the characteristics of process models developed within firms. It was exploratory in identifying factors influencing implementation success. It was also explanatory as it provided evidence to better understand why problems occur during implementation efforts, and predictive, in that the understanding
from the exploratory and explanatory dimensions was used to test hypotheses. Figure 3.4 provides a representation of the data collection process of this research.

**PhD data collection process**

![PhD data collection process diagram](image)

The data collected was analysed with the support of different analysis techniques, described as follows.

### 3.7.2 Data analysis and presentation

The approaches to data analysis used within this research include content analysis and cognitive mapping. Interviewee’s accounts, captured through the semi-structured interviews, were tape recorded and transcribed, and then content analysis was conducted with the aid of a coding scheme to discern fundamental categories of thinking. Cognitive mapping was used in this research only to validate the framework to evaluate process models with a view to its implementation (further described below).

For each firm, qualitative responses were combined into narratives describing implementation in its context. By tracing implementation from the perspective of the responsible for it within each firm, a ‘story’ about each case was constructed (Eisenhardt, 1991). The stories were developed by combining the accounts of the interviewees into a timeline beginning with the decision to design a process model, in which all events mentioned were included. In this way, they describe ‘implementation
triggers’ (including expected benefits of using the model, the model description, and its analysis by applying the evaluation framework); ‘implementation outcomes’; ‘implementation process’ (presenting the strategy formulation and steps conducted); and ‘implementation content’ (describing factors affecting implementation).

These stories formed each intra-case analysis, which was then validated by the interviewees through a telephone conversation for companies A, B and C, and through a meeting for Company D. The ‘stories’ provide company-specific answers for the research questions, and describe data that has been used to test each research hypothesis.

Cross-case analysis was based on the search for patterns within the implementation stories and in the factors that affect implementation. Listing similarities and differences between each company assisted the search for patterns. The hypotheses have been tested based on the information collected at all companies, and the main implementation problems identified were described. Tables have been used describing the themes under which drivers, enablers and restrainers were classified accordingly to its influence over the triggers, content, process or outcomes of implementation.

The approaches taken towards content analysis and cognitive mapping, and the development and testing of the framework to evaluate the PDP model content with a view to its implementation are described as follows.

**Content analysis**

Content analysis has been developed for investigating any problem in which the content of communication serves as the basis of inference (Holsti, 1969). According to Krippendorff (1980:21) “content analysis is a research technique for making replicable and valid inferences from data to their context”; and its purpose is to provide knowledge and new insights through a representation of facts. The same author stresses that the technique makes possible the analysis of the symbolic meanings of messages, which is not possible through direct observation. Krippendorff (1980) and Holsti (1969) describe some requirements for content analysis, which have been adopted in this research to allow for transparency in analysis:
clearly presenting what data are to be analysed, how they are to be defined, and from what population they are drawn;
• the content relative to the data which are analysed must be made explicit, defining thus the boundaries to which the analysis extends;
• the objectives of the analysis should be clearly specified from the beginning; and
• use analytical constructs to make inferences.

As pointed out by Easterby-Smith et al. (2002), the method allowed the researcher to draw key features out of the data, whilst at the same time allowing the richness of some of the material to remain so it could be used to evidence the conclusions drawn and help to let ‘the data speak for itself’. Therefore a grounded or inductive approach, through which the codes17 emerged from the data, was used for matching observations to theory or constructs (Miles and Huberman, 1994). Written documents such as transcripts, e-mails and descriptions of the implementation process developed in the companies were used for analysis (for details refer to Appendix C).

It is worth noting that content analysis has not been used to quantify themes in the analysed documents, nor has it been used to establish their frequency or how variation is related to other variables (as, for instance, proposed by Bryman, 1989). This is due to the fact that identifying themes emerging from the data, describing information on implementation, was more important than quantifying how many times each interviewee referred to each theme. Therefore, content analysis was used here similarly to what has been described as “template analysis”. According to King (1998:118), “the essence of the approach is that the researcher produces a list of codes (a ‘template’) representing themes identified in their textual data. Some of these will usually be defined a priori, but they will be modified and added to as the researcher reads and interprets the texts”.

King (1998) defines three main stages, which include creating the initial template through prior evidence from literature and personal experiences; revising the template that involves the insertion and deletion of codes, and expansion and reduction of the scope of codes; and creating the ‘final’ template.

17 Codes are labels used to assign meaning to the descriptive or inferential information compiled during a study. Codes were used to retrieve and organise chunks of information within phrases, sentences and paragraphs, pulling together a lot of information from different sources, suggesting thematic links (Miles and Huberman, 1994).
In this research, a provisional list of codes was developed prior to data analysis, describing a descriptive label for the categories/themes and codes, and linking each code to the research question it was derived from. The researcher carefully read the interview transcripts, aiming at identifying general issues. After that, the analysis was executed through cycles in which the researcher identified variables (expressions used by the interviewee), coded the variables to the relevant code or created a new code, verified results (within the analysed text and also between the different texts analysed), and then searched again for variables relating to the new codes. These cycles occurred until no new codes were identified by the researcher within the texts being analysed. The list of categories and codes is presented in Appendix D.

The recording unit used for coding was based on phrases or paragraphs, and codes reflected different themes. Paragraphs were used instead of words as their meaning could be better inferred during the analysis, providing richness to the themes developed. Categories for analysis have been constructed based on the research questions.

Content analysis was done manually at the exploratory cases, and the software NVivo\textsuperscript{18} was used to support it at the main case study. Some of the advantages of using a software to support content analysis have been described by Robson (2002): they provide a single location storage system for all stored material; text can be easily manipulated and displayed in various ways, (e.g. showing all sentences related to a particular code); they help the establishment of rules for coding; different types of searches can be made automatically by the software as such rules have been established; and it allows one researcher to handle a large number of documents.

In this research, data was also analysed with the assistance of a framework to evaluate the knowledge content of process models’ with a view to their implementation. As the object to be implemented is the process model, it was necessary to design a framework to evaluate its knowledge content and help identify how it affects outcomes. The design, testing and application of such a framework is discussed in the following section.

\textsuperscript{18} QSR Nvivo revision 1.3
Framework to evaluate PDP models with a view to its implementation

The PDP literature presents concepts that can be used to evaluate process models. However, these concepts are scattered throughout the literature. To address this gap, a framework has been proposed based on the literature that aims to support the evaluation of PDP models’ content regarding its implementation. The framework was organised in three hierarchical levels: (a) the high-level evaluation criteria; (b) headline criteria, describing concepts that are part of overall criteria; and (c) attributes that describe each headline criteria. The framework is presented in Figure 3.5.

Two high-level evaluation criterion were determined, i.e. applicability and usefulness of the model. The applicability of a model in the business context (Smith and Morrow, 1999) is concerned with its capability to be used to support PDP management. Model usefulness (or importance) addresses the model’s pertinence in terms of what it adds to the business.

![Model Evaluation Diagram]

**Figure 3.5: Framework to evaluate product development process models**

The concept of model applicability is described through three headline criteria, i.e. the model flexibility (Cooper, 2001), its ease of use (Kagioglou et al., 1998; Bresnen and Marshall, 2001), and model credibility (Smith and Morrow, 1999). Process model flexibility is necessary to allow the model application and replication through the company’s projects. Kagioglou et al. (1998) regard flexibility in terms of the process phases, as the number and content of such phases should be adaptable to the project in
hand. Flexibility is also considered in terms of the functional roles, the deliverables, and the distribution of workloads between professionals in accordance with the specific project needs (Cooper, 2001).

A process model needs to be easy to use so that it can be applicable to support PDP management. Ease of use can be assessed in terms of the simplicity and clarity in the presentation and structure of the process model, as well as through the simplicity and clarity of its knowledge content. Smith and Morrow (1999) point out that the simpler the model is, subject to reproducing the behaviour observed in the world to a necessary level of precision, the better it is. Kagioglou et al. (1998) supports this idea, stating that process models need to be transparent, defined simply, and it should be related to a straightforward icon to which people could attach their interpretations of it.

The knowledge content of a model should be clearly defined, and have an obvious internal coherence, otherwise the model could be perceived as a bundle of loosely related practices (Bresnen and Marshall, 2001). In this way, the model should present proper codification in a commonly held set of principles and practices. It can be assumed that when a process model lacks a clear definition of its objectives and of the improvement principles included, it will be difficult to use.

The final issue with regards to process models’ applicability refers to the model credibility, or user acceptability of the model. The model credibility refers to the degree of conjecture on the utility of the process model (Szulanski, 1999; Dixon, 2000). If a process model is not perceived as credible, it will probably not be used to guide decision making within a project environment. Credibility therefore is important for both the model applicability and its usefulness.

A process models’ usefulness is assessed through two further headline criteria i.e. the model validity and measurability. Validity is addressed by analysing if the model adequately captures the actual state of the process, as well as analysing if it effectively describes changes to be introduced. Smith and Morrow (1999) further propose that a model’s validity can be assessed through the application of the model to guide decision making in the real world through piloting, which also supports the models credibility.
Finally, measurability concerns the existence of performance measures as part of the process model. A difficult implementation problem relates to the difficulties in producing clear evidence of performance effects (Bresnen and Marshall, 2001), as it is hard to compare projects with one-off characteristics. In any case, it is important to try and measure at least partial aspects of the process model application, in order to provide some evidence of the improvements achieved.

Empirical data from Company A was used to validate the framework (see section 4.2.3), as this was the only case study company where implementation was successful. Diverse concepts were identified through the interview transcripts relating to the high-level evaluation criteria, i.e. applicability and usefulness. Those concepts were then organised in cognitive maps, which were used to test the process models’ evaluation framework. They also helped to generate new theoretical insight with regards to the role of process models within firms.

A cognitive map is a description of an individual or several individuals’ concepts about a particular domain, being composed by ideas and links between these ideas (Miles and Huberman, 1994). The links between ideas are causal links, being understood as: (a) A is the explanation of B; (b) B is the consequence of A; or (c) A is the means and B is the goal. Cognitive maps have been drawn from a particular piece of text (i.e. interview verbatim transcripts from Company A). Therefore, the researcher interrogated the text rather than the persons. The software decision explorer was used to support the creation of cognitive maps. One advantage of the software is that it allows the identification of the ‘centrality’ of an idea, which is used to identify strategic issues on a map. This is done by identifying concepts with a greater number of links (Rodhain, 1999).

A further tool was used in this research to graphically represent factors negatively or positively affecting implementation, i.e. force field analysis, which is described as follows.

**Force Field Analysis**

Force field analysis is a diagnosis tool developed by Kurt Lewin which can be used when observing the variables involved in determining change effectiveness and when planning and implementing a change management program. In this research, it was used to provide a graphical representation of drivers and restraining forces affecting
implementation. Only factors identified within the main case study were represented in such a way as they were greater in number than the factors identified at the exploratory cases.

The forces ‘for’ and ‘against’ implementation, defined with the help of content analysis (based on the codes from interviews and document analysis) were organised in a list. Then, a score was assigned to each force, from 1 (weak) to 5 (strong). The researcher inferred a score based on the relative importance of each factor identified, therefore a scoring of ‘low’, ‘medium’ and ‘high’ has been used. Following that, a diagram was drawn demonstrating such forces, as represented in Figure 3.6. Such diagrams are presented in section 5.2.7.

![Diagram: Driving and Restraining Forces in Equilibrium](image)

Figure 3.6: Force field analysis

A fundamental qualitative research issue is the evaluation of the quality of the research design (Reimenyi et al., 1998). The next section discussed the validation issues of this research.

### 3.8 Validation

The research design should be sufficiently rigorous to provide support for the study to be believable and trustworthy (Robson, 2002). Therefore, validity, reliability and generalisability should be considered within phenomenological research, even though
the criteria for evaluating such issues was developed for positivist research designs (Remenyi et al., 1998). As interpretative research is different in nature from positivist approaches, the standards used should also be different, and they usually refer to whether there has been consistency and integrity in the design of the study (Remenyi et al., 1998).

Furthermore, it is acknowledged that case studies can be criticised on the basis of lack of rigour, including bias (Yin, 1994; Robson, 2002), because the data gathered is mostly based on the perceptions and subjective interpretations of the researcher. Furthermore, problems of generalisability have also been pointed out, as the approach focuses on one or a small number of cases and therefore generalisation would not be justified (Meyer, 1977). The concepts have been used to reduce the effects of such problems, i.e. validity and reliability of the research process are discussed in turn.

### 3.9 Validity

Kerlinger (1979:138) argues that ‘validity is often defined by asking the question: are you measuring what you think you are measuring? If so, your measure is valid, if not, it is not valid’. In interpretative, non-positivist research, validity concerns whether the researcher has gained full access to knowledge and meanings of respondents (Remenyi et al., 1998). Therefore, it is important to get good quality access to enable such contact to be made on the research site, as it has happened in this research.

As described by Blaikie (1993), issues of objectivity and validity are viewed differently from within the various approaches to social enquiry, ranging from the use of procedures which claim to achieve them (e.g. construct validity, internal validity and external validity proposed by Yin, 1994) to a complete denial that validity can be established. In this research, it is assumed that there are truths to be known about the way the social world works, and therefore regularities can be discovered and explained through theory. In such way, it is recognised that theories can always be replaced by better theories (Robson, 2002). In fact, ‘the regularities in social life are not universal; they change over time and can differ across social contexts’ (Blaikie, 1993:6).

In this way, the story telling approach used to describe case study results (section 3.7.2) is suitable. As Remenyi et al. (1998:185) points out, ‘the story will always be told from
the point of view of the story-teller or writer and thus there may be different stories told about the same event or series of events’. In this way, the pre-understanding and understanding that different researchers use as lenses or viewpoints through which they understand and describe the world are acknowledged. Furthermore, if the case study story is useful and contributes to an understanding of the world or it explains interesting phenomena, then the case study value will be acknowledged, and it will contribute to knowledge (Bourgeois and Eisenhardt, 1988).

Remenyi et al., (1998) present indicative questions regarding validity in hermeneutical research, which are presented in Table 3.1. The ways in which this research addressed such questions are discussed as follows.

<table>
<thead>
<tr>
<th>Concerns of the hermeneutical researcher</th>
<th>Indicative questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quality of the researcher as a sensing instrument</td>
<td>How sensitively and effectively has evidence been collected?</td>
</tr>
<tr>
<td>2. Transparency of the research process</td>
<td>Is it clear that evidence was collected and interpretations made?</td>
</tr>
<tr>
<td>3. Quality of relationship with respondent</td>
<td>Was the relationship sterile or has there been participation and empathy?</td>
</tr>
<tr>
<td>4. Quality of argument in the interpretation</td>
<td>Is it plausible? Is it reasonable and useful? Has it been negotiated with those involved? Is there goodness of fit with the situation? Can it be used as basis for action?</td>
</tr>
</tbody>
</table>

The use of multiple sources of evidence and multiple informants aimed to address the sensitivity issue, thus allowing the triangulation of data methods and sources, aiming at achieving a good fit between reality and theory. Triangulation is possible when more than one research technique is used, and the results from one technique are cross-checked with the results of the other to achieve greater reliability (Jankowicz, 2000). In this research triangulation was approached through:

- **triangulation of theories**: by reviewing literature in different areas, such as manufacturing and construction, and looking at implementation from different viewpoints (see chapter 2);
- **triangulation of data**: by using multiple sources of data collection (see section 3.6); and
• **triangulation of data analysis**: by the use of descriptive (e.g. Table 4.1) and explanatory displays (e.g. Table 4.5), content analysis and cognitive mapping (see chapters 4 and 5).

The transparency of the research process was addressed by developing case study protocols and keeping records of research design decisions and reasons for this through logs (see next section), therefore the way evidence was collected and interpretations made is clear. The relationship between the researcher and the informants is considered to have been one of participation, which allowed for results to be confirmed and negotiated with informants. The results are considered to be useful as they provided evidence on the problems affecting implementation, which made possible the proposition of recommendations for better effectiveness in future implementation.

### 3.9.1 Reliability of the research process

Reliability refers to how replicable the study is, if one considers that similar observations should be made by other researchers on different occasions (Easterby-Smith et al., 2002). Even though it has been argued that it is not possible to find the same results through replicating the same procedures because each organisation is different (Remenyi et al., 1998) and each researcher perceives the world through their own theoretical perspective, it is still important to ensure that the data collection and analysis process are robust.

Reliability was approached in this research by developing case study protocols, and by keeping the evidence collected in an easily retrievable format so that any researcher could have easy access to all explicit information used in the research, i.e. keeping logs of the research activities executed within each case (see Appendix E) and linking such logs with company documents, reports on the research process and interview transcripts.

### 3.9.2 Generalisability

Generalisability concerns the applicability of theories developed in one setting to any other setting (Robson, 2002). As pointed out by Gummesson (2000), qualitative research should enable one to attain a good understanding of organisational processes, therefore generalisation should be understood as involving the use of in-depth studies
based on exhaustive investigations to identify certain phenomena. Based on such exhaustive investigations, the understanding of processes gained on companies could then form the basis through which such processes are understood in other, similar companies through analytical generalisation (Remenyi et al., 1998).

In this way, the findings of this research have been generalised to theory (see sections 7.2, 7.3 and 7.4), which could be used as a vehicle to examine other similar cases. The sampling strategy was not focused on finding ‘representative’ cases, as it is always difficult to generalise from one case to the next (Yin, 1994). However, sampling included large-sized companies, therefore the results are not considered generalisable to small and medium enterprises, which present very different contextual characteristics.

By the detailed description of the case study data and the testing of the hypothesis in each case, the replication logic (Yin, 1994) has been used to find results which were similar across cases and, therefore, can be accepted for a larger number of similar cases.

### 3.10 Summary

This chapter presented the method used for this research. The chapter started by describing the need for a nested approach for the research methodology. Then, the use of the hermeneutic learning spiral as research philosophy was described. Subsequently, the case study approach developed through this research was presented, followed by the different research techniques employed. The process used for data collection and analysis were then described. The chapter concluded with a discussion of the validation aspects of the research.

The next chapter presents and discusses the research results.
4 Research findings: preliminary case studies

4.1 Introduction

Chapter three concentrated on setting out the design and development of the methodology used in this research. This chapter focuses on describing the main data collected and its analysis within the context of the research questions and hypotheses.

The chapter presents an overview of the three preliminary case studies. A more extensive description is given to the out-of-industry case study, as it was the only case in which a process model was successfully implemented. Narratives are presented for each case, describing triggers (i.e. why the company decided to invest in process models), the implementation content (i.e. the nature of improvements in the process models developed), the implementation process (i.e. the strategy and steps undertaken to design and implement the model), and the main outcomes in the company (i.e. success or failure). This makes possible an analysis of the different contexts in which the process model implementations occurred.

4.2 Preliminary case study: Company A

Company A is the only out-of-industry case study of this research (see chapter 3). It is a major global provider of telecommunications and information technology solutions, employing over 48,000 people in 100 countries. Most of the company’s products are customised, and different strategic business units host each type of product developed. The company products can be classified as:

- broadband switching infrastructure (applications for networks);
- access and transmission products; and
- optical networks infrastructures.

The company structure is divided into three main areas: core operations, capital operations and sales and marketing. Core operations contain all strategic business issues covering the global supply chain and manufacturing and is divided by business type, i.e. network equipment (optical networks, access and broadband routing and switching) and network services (i.e. installation, commissioning and maintenance).
Capital operations include mobile activities, ‘Company A’ on line and other investments. Finally, sales and marketing comprises all sales, including costumer requirements fulfilment. According to the projects development manager, this gives the organisation a fragmentation problem, as each business unit is independent within the company:

‘optical network develop the optical products, access develop the access products,…that organisation gives you a problem straight away when you are trying to sell or deliver a solution, because … the global supply chain provides the manufacturing element, although the resources comes from others’\(^{19}\)

4.2.1 Implementation triggers

This section describes the main drivers for implementation, and discusses the appropriateness of the PDP model content. It initially describes the problems the company faces in managing the PDP in order to provide background information on the implementation need. The expected implementation benefits are then presented. The section concludes by describing two process models designed by the company.

Company problems in managing the PDP

Product development in Company A is complex and there is great variability between different development efforts, because their products have different characteristics and levels of complexity. PDP varies from relatively small and short-time efforts in which the complexity of the product is low, to long-term efforts through which highly complex products are developed for periods as long as three years.

The success of the PDP in the company tends to depend greatly on the capability and role remit of the project manager. The project organisation can be considered as heavyweight (Hayes et al, 1988), which contains strong project links, aiming at improving coordination efficiency. The project manager has budget authority, is involved in the team performance evaluation, and makes resource allocation decisions.

Managing the interfaces between the different processes required in a project is challenging as it involves people from different parts of the company, i.e. engineering, technology, costs, product functionality, design for manufacturing, product installation,

\(^{19}\) This chapter presents extracts from the interview transcripts which are always presented in inverted commas and italics.
training, services and long term support. The problems involved in managing such interfaces are even greater where distributed design teams are used. Furthermore, in order to support the project manager and better manage project interfaces, the company attempts to involve all specialists from the beginning of a project. Nevertheless, this is difficult to achieve as it increases product development costs.

Linking product development and marketing is also important and challenging, as resources need to be committed sometimes two years in advance of a product launch, and the marketing unit needs to understand what the product will offer the customer before it is developed. A usual problem is that product functionalities change during product development and marketing is not informed about such changes, which usually compromises the timing of the new product introduction in the marketplace. Linking product development and production is also problematic, and a common problem arising due to poor integration is that well designed products sometimes present problems in installation due to inappropriate information flows from design to manufacturing.

Finally, the company faces high risks in introducing new products to the market. The business case for each product needs to be updated constantly, including information on the marketplace in which it is to be introduced, as competitors could introduce similar products at lower costs at any time.

**Expected benefits of using process models**

Company A has decided to invest time and resources in designing and implementing a PDP model aiming to achieve diverse benefits. The expected benefits identified in Company A are very similar to the espoused benefits presented in the literature (see section 2.2.4). Benefits are expected for the organisation as a whole, for the product development process and for the client.

The main reason for designing process models was to reduce the occurrence and the effects of the problems previously outlined. Initially, the company believed that this could be achieved as the model would improve planning and control through the PDP. The organisational wide benefits identified relate to the ability of the model to:
help the company achieve success in all projects, better managing variability between projects;

- define a ‘best practice’ process that embodies discipline and business planning;

- assure consistency between the PDP and IT systems;

- help the company determine and meet market and client requirements in a timely, cost-effective and defect-free manner;

- help avoiding project failures through better management and reduction of the risks involved in positioning new products into the market; and

- be used to train employees, providing stakeholders with a whole project view, increasing understanding of activities from different business areas/stakeholders;

In terms of the benefits expected for the PDP itself, the following were identified:

- shorten development times;

- support project management in defining the size, scope and timing of each project;

- enable all stakeholders to understand project priorities and client requirements in a similar fashion;

- enable better and timely communications between stakeholders;

- define phase reviews, leading to predictable timing for the release of project deliverables.

Finally, from the client’s perspective, the company expected to achieve better product quality resulting from a better managed process, which supports customer requirements management and makes possible the timely delivery of products to market.

Therefore, from the espoused benefits identified in the literature, only partnering (Winch, 2002) and benchmarking for improvement (Ulrich and Eppinger, 2000; Cooper, 1998) were not identified in the interviews. Partnering is not a strategy that Company A intended to adopt. Benchmarking was not approached due to difficulties in measuring the PDP in a way that could be comparable between the different business units, using measures other than time and costs (see section 4.2.3). In fact, most benefits identified are qualitative and hard to evaluate through specific measures.
In summary, the main triggers of designing and implementing the PDP process in Company A were to reduce PDP managerial problems by establishing one generic model describing ‘best practice’, which would allow for product development control. The model also aimed at providing all stakeholders a consistent understanding of the whole process.

**PDP models description**

Company A has successfully used different process models to manage its PDP for more than 10 years, therefore a brief history of such initiatives is presented as follows. The improvements proposed in the models designed in Company A are presented through a description of ‘lifecycle management’ and ‘solutions management’ models. Both models are presented as the first was being applied in the company and the second describes further improvements.

The first process model the company designed described five key business processes the company had at that point in time: strategy; planning; product development; costumer requirements fulfilment; and installation and commissioning. The process model had three different levels of detail, whole project view, activity and task levels. During the design of this model the company appreciated the need for hierarchy and therefore different levels of abstraction in a process model.

As a consequence of such understanding, as well as due to the need for inputting support information attached to process activities, the company decided to develop a more detailed model. The IDEF0 modelling technique was then used, describing information flows and activities through inputs, outputs, constraints and resources. The final model presented more than 100 pages of activity descriptions, and was considered rather ‘complex’ by the company members. The shortcomings of this approach were soon realised, as the model did not allow for any interpretation or adaptation and therefore could not be adapted to suit the diverse needs of the different business units, leading to unsuccessful implementation.

Due to such shortcomings, the company decided to redesign the PDP model and developed ‘lifecycle management’. The process’s guiding principles described in this model were successfully adopted by different strategic business units of the firm. As
stated in interview 1, the model ‘enables project teams to make considered investment decisions through the stage gate process’.

Nonetheless, a major change in the business was taking place during the time the interviews were executed, mainly due to a reduction of company share in the telecommunications market and consequent financial problems experienced in 2001. To overcome such problems the company changed its strategic direction from selling products to selling solutions to the customer, i.e. developing and installing networks and enabling communication exchanges to meet specific customer needs. As a consequence, a new PDP model was designed aimed at bringing the complexities involved in delivering a solution to a client into a single model, therefore linking product development and the business processes related to delivering a solution to a client, i.e. ‘solutions management’. This allowed the expansion of the content of the lifecycle model, broadening its project manager perspective to include a more holistic business approach. However, the key principles of the lifecycle management model remained valid.

Therefore, it is possible to observe that the design and implementation of process models within Company A is not a one-off activity, but rather a process of continuous change and improvement. The lifecycle management model is described as follows.

**Lifecycle management model description**

Lifecycle management describes product development as a business-driven process that encourages a holistic approach to project management by viewing the project through a complete set of phases, with gates attached to each phase. It is defined as ‘a guide to phase reviews’, described from the perspective of the project manager. It is divided into two complementary models: the product lifecycle describing the PDP; and the contract lifecycle describing the main phases in managing contracts and turnkey projects. As this research focuses on PDP models, only the product lifecycle is considered here.

The product lifecycle can be classified as a ‘to-be’ high-level model at the firm level (see section 2.2.3). It is a well-defined model, which involves a multifunctional team taking a new product from concept through to volume supply. The process is represented in a two-dimensional map, Figure 4.1, with nine phases on its horizontal axis, and a phase review attached to each phase. In its vertical axis, it is divided into 10
functions that should be involved at different project phases. Under each phase there is a group of activities of the project life cycle. The phases have specific inputs, outputs, and deliverables. Therefore, lifecycle management is a gating process which provides project management discipline.

Each of the model phases is described in terms of: (a) leadership, e.g. product manager; (b) activities to be done before phase review meetings, e.g. identify potential for new product and business opportunity; (c) a list of deliverables, e.g. outline market plan, user requirements specifications, outline system and product requirements; and, (d) goals of the phase, e.g. authority to proceed with the feasibility study.

The lifecycle management also presents a list of key principles that should be followed in managing all company projects. The principles are set out as follows:

- **Teamwork**: increased as a result of the model use through the definition of activities, stakeholders roles and when their contributions are needed;
- **Concurrency**: Company A aims to actively drive activities in parallel rather than in sequence. Nonetheless, in most of the projects that is not possible due to the increased complexity involved in managing concurrent processes;
• **Flexibility:** the model presents an example of how it could be adapted for the different projects by merging phases and reviews and customising deliverables;

• **Added value:** it is important to quantitatively measure improvements to allow the company to assess the benefits from using processes – focus on time and cost;

• **Time-to market:** regards the reduction of product development times, allowed by better product development planning and early involvement of stakeholders.

The model has a continuous improvement aspect, as there is a number of reviews defined at the project outset. These allow the feedback of individual learning experiences into the high-level model. The model also has guidelines for successful implementation:

- having a product manager or sponsor who owns and actively manages the needs and expectations of the market/costumer;
- having an accountable project manager with authority in all functions involved;
- defining a risk management plan which identifies and quantifies risk; defines actions to mitigate risks and is regularly monitored and updated;
- defining a project management plan that: all parties are committed to; pulls together all project sub-elements; schedules due dates of phases and deliverables; clearly identifies stakeholders responsibilities; details the process for monitoring and reporting progress against the plan;

A further good practice proposed in the model is the involvement of a chair person responsible for the reviews of individual project deliverables throughout the process. This person is independent of the project, and in some instances independent of the business unit, which brings impartiality to the evaluation process. Such a person identifies if projects are appropriate for the period in time and for the marketplace, and if they are not, the project is stopped. As pointed out in interview 1, ‘*the project team get involved with the project they never to stop it*,’ and this could bring great losses for the firm.

**Global solutions management model description**

When the interviews were executed global solutions was still under development, therefore the version available in February 2002 is here described. The idea of linking
business processes to the PDP was important as the need for more integration between product development, manufacturing and support services was realised. As the company started to install, commission and test new equipment on the customer site the services’ personnel needed to be involved in new products design. As services were not included in the lifecycle model, it needed to have a separate model for its activities. As a consequence of the lack of integration of the models, services could not plan its activities, as they did not know which products they would have to support in the future. Therefore, solutions management was developed to provide more integration.

Solutions management presents a pictorial (metaphoric) view on the process. In Figure 4.2 the process is represented as linear, but the company recognises that many processes occur in parallel and are interdependent. The background boxes represent responsibilities over activities, e.g. account manager. The dotted boxes represent the multifunctional team that is responsible for executing and supporting the activities (e.g. bid team). The thick arrows represent main activities, and strategically important documents are linked to some of them (e.g. market plan or bid strategy).

Figure 4.2: Company A’s global solutions management process
Solutions management presents three levels of detail on its description. The high-level model is described in Figure 4.2. The second level of detail describes activities and outputs (represented through arrows in Figure 4.2), as well as the main phase reviews. The third and final level represents procedures for the execution of specific tasks, describing: (a) the purpose and objective of the activity; (b) list of tasks; (c) inputs and resulting deliverables; (d) possible timing for the activities; (e) role, i.e. the function that is responsible for the activity; and, (f) supporting documentation, e.g. tools, checklists.

4.2.2 Implementation outcomes

The use of PDP models in Company A is considered successful, as most major projects go through the phase review process. Although every business unit uses the process model, it is not always applied to the same degree, i.e. some projects adopt the model consistently and consider all principles, while others only apply it partially. Even though, both interviewees felt that the use of the model has added value for the business.

The success of the PDP models used was directly related to the level of detail of the model itself. It was stated in interview 2 that ‘the process model should not be too detailed as this would undermine its adoption’ due to the increased difficulties in adapting it. The use of a structured modelling methodology (IDEF0) was not appropriate as the resulting model was too complex to be adaptable to different projects. Therefore, implementation was successful as the model presented a set of key principles and guiding lines, which were generic, flexible and adaptable. Figure 4.3 shows the relationship between the level of detail of the process model and implementation success in Company A.

Implementation success was also related to formulating a strategy which was not prescriptive (see section 4.2.5), but rather focused on involving and motivating people to achieve buy-in and commitment. Success relies greatly on the project manager that, as stated in interview 1, ‘has to be very persistent and has to have good persuasive interpersonal skills’ to overcome the barriers to change. Also, success was influenced by the focus on training and the careful planning of the preliminary implementation stages, i.e. awareness of need and clearly demonstrating benefits.
The applicability and usefulness of the PDP model content within the organisational context also played a decisive role in terms of implementation success, as discussed in the next section.

**4.2.3 Validation of the framework to evaluate a PDP model content focusing on its implementation**

This section presents the validation of the framework to evaluate PDP models with a view to its implementation (see section 3.7.2). Data from Company A was used to validate the framework, as this was the only case study company where implementation was successful.

Figure 4.4 presents concepts related to process model applicability. In the framework drawn from the literature, three headline criteria were associated with applicability, i.e. flexibility, ease of use and credibility of the model. These criteria were also used in the cognitive maps to classify the concepts identified. In Figure 4.4, concepts related to flexibility are represented through ovals, squares present concepts related to ease of use, and loose concepts are related to model credibility.
Figure 4.4: Cognitive map: Applicability of the PDP model as identified in Company A

Map Key: flexibility concepts are presented in ovals, ease of use concepts are presented in boxes, loose concepts relate to the model credibility
The analysis of the centrality of each concept demonstrated the following strategic issues with regards to applicability: (a) the process model should be flexible -12-, (b) the model should be approached as a framework, describing a scenario -17-; (c) the model needs to be generic -7-; and (d) the model needs to be redefined and rethought constantly -19-. This corroborates the literature findings in the need to evaluate a process model considering its flexibility, ease of use in terms of the need for the model to be generic and simple, and credibility as the model should be describing a scenario.

Data suggests that flexibility should be addressed in different ways, i.e. (a) a model should be flexible to adapt to different business units in the company -45- (e.g. business units should have local variations of the model); as well as (b) to different project types, sizes, objectives and complexity, including the reviews and deliverables needed for each project. In this way, the principles remain the same but the activities change from one project to the next -48-; and, finally (c) it should be flexible to allow updating in order to respond to changes in the business environment -1-26-.

Both the model presentation structure -301- and the simplicity and clarity of its knowledge content -317- contributed to ease of use. Emphasis was given for the importance of the model being presented simply (see Figure 4.1) for two reasons. First, having a generic, simple model was the only way to address flexibility, necessary for successful implementation. As an example, it was stated that the activity level is not transferable between projects, therefore models should be generic. Second, high-level models allow managers to think over the process, to be creative and innovative while considering key process principles. Finally, the model is published in the company intranet, allowing the presentation of support information behind its stages in a simple manner. Thus, IT is used to support the model presentation and dissemination.

The model credibility in Company A was identified through the emphasis that people should believe that the model content adds value to the project and the business -9-.

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20 This number refers to concept number -12- in the cognitive map presented in Figure 4.4. This notation is used throughout this section.
There is a clear recognition that ‘it’s people who make the process work or not’ (interview 2), and sometimes ‘mavericks’ (interview 1) damage implementation as their beliefs are different from the beliefs of the process model developers and supporters (e.g. ‘they believe that their current way of conducting the process is better than the new way proposed in the model’ – interview 2). People believing the model adds value was considered as the only means to achieve commitment to the model use -311-, and lead to a critical discussion of the role a process model should have -315-.

The initial belief was that a model should be used as an overall plan of the process (as generally proposed in the literature), and as such its use was to be mandatory. It was soon realised that having a mandatory model was an ineffective implementation strategy due to two main reasons: (a) it generated resistance to change; and (b) the model becomes bureaucratic, and hinders creativity: ‘it takes out the ability of people to find out the best way of developing a project’ (interview 2).

As a consequence, it was realised that PDP models provide value only if approached as a framework, through which scenarios, opportunities and threats for the project in hand can be discussed-17-. Thus, a shift occurred in the role of the model, which moved from this hard ‘plan’ perspective to a softer, ‘learning’ perspective, through which managers could apply good practices as appropriate. The importance of involving people through workshops and focus groups to achieve a similar understanding of the models’ key principles and increase acceptability in the company was also realised-312-.

Figure 4.5 presents the cognitive map describing the process model usefulness in the case study company. In the framework drawn from the literature, three headline criteria were associated with usefulness, i.e. credibility of the model, validity and measurability, which were also used in the cognitive maps to classify the concepts identified. In Figure 4.5, concepts related to measurability are represented in ovals, concepts related to validity are represented through boxes, and loose concepts relate to the process model credibility.
Figure 4.5: Cognitive map: Usefulness of the PDP model as identified in Company A

Map key: Ovals present concepts related to the model measurability; boxes present concepts related to the model validity; loose concepts relate to the process model credibility.
The analysis of the centrality of each concept demonstrated the following strategic issues with regards to usefulness: (a) the model should appropriately describe the process; (b) it should appropriately describe changes and improvements proposed; (c) the model needs to be simple rather than detailed and complex; and (d) the model needs to present a set of key principles rather than tell people how to manage a project. This corroborates the literature findings on the need to evaluate models considering validity (section 3.7.2). It also makes evident the importance of credibility for user acceptability.

According to the concepts identified, for a model to be valid it has to describe the process in an abstract, generic, and simple way, presenting ‘logic and common sense’. It also needs to define responsibilities and pull all the different elements and stakeholders involved in the process together, supporting the team in getting the project baseline right (i.e. defining a business case, capturing client and business requirements, defining manpower and skills needed, costs and investment, as well as return on investment). In addition, it needs to be updated regularly so that it would suitably describe the process over time, which changes due to both internal and external pressures.

The need for model simplicity makes explicit the need for adopting flexible modelling methodologies. As described earlier, it was not possible to implement over detailed models (section 4.2.1). On the other hand, it is recognised that problems can arise from the fact that the model is generic and uses abstract language. Stakeholders can understand it differently, which could be harmful as it obscures the perception of benefits.

For the process model to be credible and, therefore, establish user acceptability, it needed to be: (a) scalable and transferable; and, (b) based on what people do and agreed with its users, and so a bottom up approach to modelling was appropriate. This also allowed for the content of the model to be pulled from users, rather than imposed or pushed to them, which increased acceptability.

21 The numbers in this section refer to Figure 4.5.
Finally, the existence of performance measures was not essential for the model usefulness-38-, but the importance of clearly demonstrating benefits from the model use was acknowledged. Performance measures were not applied as it is difficult to keep them aligned with the business needs and functions, especially in an environment of constant business changes as faced by Company A. As stated in interview 2:

''when the organisation changes, its new functions will need a whole new different set of KPIs; then you could look back historically and say lets put down that one and use that one..... So every time the organisation has changed the KIPs has been thrown away and restarted.''

In summary, the proposed framework is appropriate in terms of describing the main issues that need to be considered to evaluate a PDP model content with a view to its implementation. Based on the findings discussed above, the following changes were included in the framework: (a) model flexibility: generalisability to different business streams and updating the model throughout time; (b) model credibility: approaching the model as a scenario where the process can be reflected upon and discussed; and, (c) model credibility and validity: clear definition of the model role in the company, which needs to be agreed with users. Figure 4.6 presents the final framework.

Figure 4.6: Final framework to evaluate PDP models focusing on its implementation
4.2.4 Discussion: research hypotheses H1 and H2

The data presented and analysed here provides support for the research hypothesis 1: \textit{H1}: \textit{Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful.}

In Company A, the PDP model implementation could only become successful when the model was simple and flexible enough to be considered applicable by its users. The model developed through IDEF0 methodology was considered difficult to use and inflexible due to the excessive amount of detail in the activities presented, and in this way it could not be validated through pilots and, therefore, was not successfully implemented.

Model usefulness in Company A is closely related to the role of the model, which is approached as a ‘learning framework’ providing room for reflection and innovation, as opposed to being a ‘planning and control’ tool. In any case, appropriate control and formality is set in the process through the adoption of phase reviews.

On the other hand, the data presented and analysed here do not provide support for the research hypothesis 2: \textit{H2}. \textit{Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use.}

In the case of Company A, implementation was successful even though no clearly defined measures of performance were adopted. Even though, the interviewees acknowledged the importance of explicitly measuring the benefits that accrue from the PDP model use. Therefore, high PDP model implementation effectiveness was achieved independently from clearly measuring benefits from the process model adoption.
4.2.5 Implementation process

The strategy executed to implement the PDP models in Company A is described in this section. As different models have been used throughout the years, a generic description of the steps usually conducted is presented. The section also describes how knowledge is transferred from the model developers to its users, and how model adaptation and reinterpretation happened.

Implementation steps

The generic implementation steps described by the interviewees are represented in Figure 4.7. The process is divided into three stages, i.e. pre-implementation, implementation and post implementation. The steps establish why implementation is needed, i.e. reason and purpose of the project, who should be involved and how implementation is conducted.

![Figure 4.7: Steps of the implementation process in Company A](image)

For Company A, implementation starts by clearly identifying the need for the PDP model. This means identifying what needs to be done and what would be the benefits of satisfying the need. To do this, the organisation considers if the needs are tangible and
feasible, and describes those in a benefits case for implementation. The scope of the PDP model and its implementation are defined, considering the size of the organisation and the effects that the changes to be introduced could potentially generate in the different business units, enabling the project to be feasible.

Subsequently, the company defines inputs and outputs for the process model, as well as the high-level process requirements. An implementation strategy is then developed and agreed with key stakeholders from all business units, considering how the model would be designed (i.e. bottom-up approach), and what would be the main strategies for its adoption throughout the company.

A dedicated team to deliver and support the adoption of the model, i.e. the ‘core development and implementation team’ was defined and agreed with top management, and therefore it is secured within the organisation. This team identifies people who need to be involved and define how such individuals would acquire process ownership across the business. It was described in the interviews that to make process ownership possible, the main stakeholders involved should agree with the PDP model content. Involvement of the right people is essential to provide the necessary commitment to implementation.

Thus, the identification of the beneficial people for the process is done early on as such individuals support the model design and implementation. In this way, the model users get engaged from the beginning by inputting their needs and giving feedback to the PDP model design team. This is done as a means to speed the change process, as well as to assure future users commitment. It was recognised that it is the users who are ‘the power base and driver of process implementation’ (interview 2). It has also been emphasised that once people understand the benefits the model, the necessary changes occur easily.

The implementation then goes through a group of steps similar to the steps proposed in the BPR literature (section 2.4.6). These involve defining the ‘as-is’ process by consulting project managers from diverse business units, and identifying various procedures that should be integrated or improved as part of the model design. In this way,
current problems and improvements needed are defined and described as the new process requirements. User responsibilities are defined, and how the process could be adapted by the different business areas. Also, the tools and technology to be used to publish and support the model are determined, as well as the procedures, guidelines and working instructions that underpin the high-level model. Following, key success criteria for the PDP should be determined. Nonetheless, performance indicators were not developed for the two models here presented (section 4.2.1).

Both models have been published in the company intranet, making information easily available to all. Also, training was provided for all company’s project managers. All models were validated through pilots in life projects, and then rolled out to the whole company.

Company A places great importance on refreshing continually the PDP model to suit organisational changes. The model is continually assessed and improved, including its guides, operating instructions, the marketing strategy and the use of support technology. The core development and implementation team is responsible for this constant analysis and improvement, and the different models mentioned earlier have been developed as a result of this effort. The team is also responsible for constantly refreshing the model, its ownership, review performance and maintain flexibility in the process application.

**4.2.6 Discussion: research hypotheses H3 and H4**

The data presented in section 4.2.5 provides support for the research hypothesis 3: \( H3: \) Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation and adoption does not occur.

When the model was initially developed there was a belief that even though there are differences between business units, lifecycle management should be describing all PDP
for all business areas. Also, the core implementation team did not agree that ‘specific’ business units’ models should be developed. Nonetheless, the model describes the key process principles, but it does not provide specific information on how to execute activities at operational levels. Therefore, it was difficult to implement the model within the different business units.

As a result, the company realised that it would be important to have local variations of the high-level model within the different business areas. Such local variations embed the same principles of the high-level lifecycle management, but at the same time describe the way the different business areas apply it. In such way the understanding of the high-level model and of the principles behind it increased throughout the company.

Thus, having local variations of the model was an appropriate strategy to increase process ownership, motivate users and to successfully transfer the knowledge content of the model from its developers to users. The different levels of ‘generality’ of processes within Company A are described in Figure 4.8.

The steps adopted by Company A in its process model design and implementation can be associated to the theoretical framework of this research, presented in Figure 2.8. An implementation strategy was formulated and agreed within the company, and as a result the high-level PDP models were designed. Such models were then adapted into business unit’ specific models. Nonetheless, no evidence was found to suggest that it was then
used as a basis to devise project specific models or project plans. It can be said that the business units specific process models were used to guide actions of the project team as they provided for learning and were used as a ‘thinking tool’, considering the specific necessities of each project.

Similarly, implementation at Company A can also be related to the change model proposed by Lewin (1947). The formulation of the implementation strategy and the PDP model design happened as part of unfreezing the current state (i.e. all activities from the beginning until develop and communicate training in Figure 4.7). Activating the project plan, training and roll-out can be approached as moving from the current way to the new way of managing the PDP. It is interesting to note that the need to maintain and refresh the process reflects that the constant changes in the business and market place need to be addressed if the model is to remain applicable. In this way, refreezing the practices embedded in the model is questionable as changes are constantly being introduced.

Data presented in section 4.2.5 also provides support for the research hypothesis 4: 

**H4:** Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP implementation and replication when compared to companies where future users do not participate in the model development.

In Company A, the adaptation of the generic into the specific process model involved objective issues related to the context-specific characteristics and working practices of each business unit. Nonetheless, it also involved the personal beliefs of the process model users. Behind every action, individual choice is based on human interest, and the possibility of choice is central to taking action. The recognition of this fact is evidenced by the great focus given to involving, engaging and committing people as part of the implementation strategy (see who? in Figure 4.7). Thus, a major part of the strategy focuses on collaboration and motivation linked to leading individuals to choices which are supportive of the PDP model implementation.
4.2.7 Implementation content: factors affecting implementation

A number of factors have affected implementation in Company A. Such factors were here classified as drivers, enablers and restraining forces associated with the process model implementation. Drivers are considered to be those events, characteristics or attitudes that accelerated the decision to implement, i.e. made implementation fast. Enablers are circumstances or conditions that may have allowed or facilitated implementation, i.e. made it easier, seem more appropriate or more achievable. Finally, restraining forces are those events or conditions that might have had a negative impact on implementation, or might have prevented it from being successful. Drivers, enablers and restrainers where further classified accordingly to its influences over the triggers, process model content, implementation process and outcomes. Those are presented in Table 4.1.

The analysis of the data in Table 4.1 demonstrates a great focus on people issues, as most factors identified relate to resistance to change, motivation, engagement, commitment, involvement, clearly defining benefits of using the model, training and leadership.

The driving factor affecting the implementation triggers in Company A is clearly defining why to use a process model. Company members became aware of the benefits that would accrue for the company and project levels through the adoption of the process as part of the definition of ‘why’. Defining the implementation scope, its inputs and outputs as well as the PDP model requirements, made the PDP model implementation seem appropriate.

The restrainers were identified as not appropriately considering the change needed at both organisational and project levels, i.e. the need for a new working environment, and lack of support from senior management. As it is difficult to quantify benefits from the model use, some project managers and top managers in the company believe that there are no benefits in the model use, which undermines implementation as it generates ambiguity in relation to the usefulness of the model. Using IT as a basis to design the process model was identified as another restraining force, as the resultant models tend not to be generic and not transferable between different business units.
Table 4.1: Factors affecting implementation triggers, content, process and outcomes in Company A

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Triggers</th>
<th>Content Improvements</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events that accelerated decision to implement Made it quick</td>
<td>clearly defining why to use a process (1,2)</td>
<td>comprehension of priorities by all stakeholders (1,2)</td>
<td>agreed strategy (1,2)</td>
<td>no evidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>motivation to design the model (2)</td>
<td>implementation team (1,2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benefits achieved</td>
<td>motivation &amp; training (1,2)</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Enablers</td>
<td>understand benefits of change (2)</td>
<td>not too detailed (1,2)</td>
<td>end user involvement with model design (2)</td>
<td>create the right business environment: support from senior management (1,2)</td>
</tr>
<tr>
<td>Allowed or facilitated change made it easier seem more appropriate or more achievable</td>
<td>definition of implementation scope (1,2)</td>
<td>represent principles that do not change (1,2)</td>
<td>implement at local levels (1,2)</td>
<td>leadership from project manager (1)</td>
</tr>
<tr>
<td></td>
<td>clearly defining inputs / outputs of implementation (1)</td>
<td>similar understanding of principles (1,2)</td>
<td>pilots (1,2)</td>
<td>team dynamics to cope with variability in the business and market level (2)</td>
</tr>
<tr>
<td></td>
<td>clearly defining process requirements (1)</td>
<td>publishing the model in a user friendly format - booklets &amp; intranet (1,2)</td>
<td>define ownership before work commences (1,2)</td>
<td>maintaining and updating the model, including people and IT (1,2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>integrating people, IT and the process (1,2)</td>
<td>user groups to analyse implementation (1,2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>have a responsible for the process (2)</td>
<td>workshops with newcomers to enforce the need for the model (1,2)</td>
<td></td>
</tr>
<tr>
<td>Restraining</td>
<td>not considering organisational change needed (1)</td>
<td>prescriptive model (1,2)</td>
<td>mandatory process (1,2)</td>
<td>not seeing benefits of using the process (1,2)</td>
</tr>
<tr>
<td>Negative impact on implementation</td>
<td>not considering the need for a new working environment (2)</td>
<td>excessively detailed (2)</td>
<td>not invented here (1)</td>
<td>using the process model as a ‘cool book’ (1)</td>
</tr>
<tr>
<td></td>
<td>senior management not understanding the value of the process (1,2)</td>
<td>language too abstract allowing for conflicting interpretations (2)</td>
<td>people see no reason to change methods of work (2)</td>
<td>difficulties in understanding other stakeholders activities and constraints (2)</td>
</tr>
<tr>
<td></td>
<td>model based on IT –not transferable (1)</td>
<td>lack of knowledge / competence (1,2)</td>
<td>people not thinking over the process (1,2)</td>
<td>business changes and process variability (1,2)</td>
</tr>
</tbody>
</table>

Comprehension of implementation priorities by all and motivation to design the model were factors that accelerated the decision to implement with regards to the knowledge content of the model. In fact, motivation is also a driver for the implementation process, and it needs to be nourished throughout time so that the model is continuously improved. Enablers related to the PDP model content were the models not being too detailed, providing a set of key principles which integrates process, people and IT. A further enabler was having a person responsible for the process, acting as a ‘refreshing vehicle’
continually reinforcing the model need. Also, presenting the model in a user friendly format made easier the absorption of the model content by its users. Model characteristics that inhibited implementation were having a prescriptive model (e.g. the IDEF0 model), which takes out the ability of people to think about the process before executing it, and using an abstract language, as this allows conflicting interpretations of the model content.

Having an agreed implementation strategy in place before rolling out the model to the whole company and the establishment of a team which would provide training and act as a motivating vehicle were characteristics that drove a faster and more reliable implementation. Other enablers were: (a) involving users in the high-level model design; (b) customising the model as a means to recognise differences across business units; (c) doing pilot implementations to explicitly demonstrate benefits; (d) defining ownership at the beginning of implementation so that people know to whom they should refer to for criticisms or clarifications on the model content; and (e) user groups and workshops to discuss and disseminate successful implementation cases and to train newcomers. Finally, having funds available was also necessary, as the above mentioned activities require a considerable amount of resources.

The restraining forces identified were related to the model being mandatory in the company, as this generated resistance to change. Resistance was a restraining force also in terms of people not seeing reasons to change current working practices, not providing enough training. It occurred as well through the idea of ‘not invented here’, i.e. people tend not to use process model if they are not involved with its design. Not managing expectations about the model was identified as a further barrier, as too high expectations generated disillusions, and too low expectation caused lack of motivation. Furthermore, getting consensus on how the model should be applied is challenging, especially where business units share different views on the process and on how it should be managed.

Finally, events and attitudes that enabled successful implementation outcomes relate to creating the right business environment, i.e. having support from top management and leadership from the project manager continuously. Also, team dynamics to cope with
variability in the business and market level was essential in keeping the model updated and also valid at the project level. This relates to the project manager and project team being able to ‘think over the process’, considering specific characteristics of the project in hand and managing people to execute a set of complex tasks together consistently. In contrast, using the model as a ‘cook book’ and not thinking through the process was regarded as an inhibitor. Other inhibitors were people not perceiving benefits and therefore not using the model, and lack of knowledge or competence to understand the whole process and activities developed by other stakeholders.

Figure 4.9 describes the relationship between the implementation actions and the main driving and restraining forces acting upon the PDP model use in Company A.

![Diagram of implementation actions, driving and restraining forces in Company A](image)

- = driving force; - = proposed actions; - = Restraining force

**Figure 4.9: Implementation actions, driving and restraining forces in Company A**

Implementation difficulties at Company A were classified accordingly to the measures of stickiness (see section 2.5.4) as follows:

- causal ambiguity happened in the over detailed model (IDEF0 approach), which was too complex to be adapted and this generated barriers to its use;
• project managers had varied degrees of conjecture over the utility of the process model; even some top managers were uncertain about the models’ value to the company;

• model users lacked absorptive capacity in Company A, described as lack of competence of certain project managers to value and apply the model;

• lack of motivation of the model developer in transferring knowledge to users or lack of users motivation was not identified as such in the interviews, nonetheless the importance of motivation as an enabler has been very much emphasised;

• the organisational context was supportive of implementation. Nonetheless, difficult strategic organisational issues (e.g. senior management not understanding the model’s value and lack of financial resources) were pointed out; and

• arduous relationship between model developers and users, and lack of reliability of model developers were not identified in the data gathered for Company A.

Therefore, it can be stated that from the eight measures of implementation stickiness, three occurred in Company A, i.e. causal ambiguity, unproven knowledge and lack of absorptive capacity.

4.2.8 Discussion: research hypotheses H5 and H6

The data presented in section 4.2.7 provides support for the research hypothesis 5: H5: Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy.

Process model implementation involves the exploration and exploitation of ‘process’ knowledge. In Company A exploitation was possible only after a certain degree of exploration happened, i.e. the exploitation of the knowledge embedded in the model was possible only after people got involved with the model design by either directly designing the high-level model or by adapting it into business unit specific models. In this sense,
the transmission of the knowledge embedded in the model occurred through its publication and via training, but for such knowledge to be properly absorbed, managers needed to get involved in model design. This was the most appropriate way by which the ‘new process’ knowledge could effect change in the company members’ behaviour.

In Company A, a team was responsible for keeping the strategy updated by identifying factors affecting implementation and acting upon them. Strategies to avoid the occurrence of some of the restrainers were put in place, e.g. when it was realised that the model being mandatory was causing resistance to change, it was formally agreed that the use of the model would be decided by each project manager. Other restrainers, such as not considering the organisational and project level change, were identified in the preliminary PDP model’s implementation and re-considered in subsequent efforts.

The knowledge embedded into the models was successfully transferred to the users by training, workshops, internal marketing campaigns, by publishing the model through booklets and the intranet and by social interactions between the model developers and users. Such variety of activities allowed means to transfer the explicit and tacit knowledge generated during the model design to the model users.

Hypothesis 6 is related to the replication of knowledge throughout different projects, i.e. the routinization of the process model within the company. Data from Company A provides support for the hypothesis: **H6: Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects than companies in which the generic model is not continuously and explicitly updated.**

The model was kept updated throughout the years through both continuous improvement and the design of new process models whenever necessary. Such emphasis in updating the model had influences on project managers as it demonstrated that the model was considered by top management to be important and contributing to competitive
advantages. It also facilitated motivation as people were engaged to continuous improvement by providing feedback, which was effectively incorporated in the model.

4.2.9 Summary of key findings

The main triggers of designing and implementing PDP process models in Company A were to reduce problems by establishing one generic PDP model describing ‘best practice’, which would allow for appropriate product development control. The models developed present a holistic approach to the PDP, viewing it through a complete set of phases with gates attached to each phase.

Implementation outcomes could be successful in the company only when the model was considered applicable, useful, and was presented flexibly and simply, describing a framework for learning as opposed to impinging ‘control’ over activities. Therefore, people actually got involved with the model design both via its development or its adaptation to a business unit’s specific models.

Company A data provided information that validated and complemented the framework to evaluate a PDP model with a view to its implementation, which include: the model being generalisable to different business units, project types and sizes; being updated regularly; having a simple presentation and a clear content; people believing it helps management; the model providing scenarios; its role agreed; it has to be piloted; it needs to appropriately describe improvements; and, finally, it should measure benefits.

The implementation strategy focused very much into people issues, e.g. clearly demonstrating benefits at the organisational, project and individual levels, and defining a design and implementation team to constantly generate commitment and buy in.

Finally a number of factors driving, enabling and restraining implementation were identified and classified accordingly to their influence over triggers, content, process and outcomes of implementation. Once more, great emphasis on people issues was identified.
4.3 Preliminary case study: Company B

Company B is a major construction contractor in the UK, being a leading international provider of specialised services and engineering solutions for clients in manufacturing, commerce, and infrastructure industries. The company has operations in North America, Europe and Asia, employing over fifty thousand people in more than forty countries. Different business streams develop diverse types of built products.

Company B has not designed a generic PDP. Conversely, it presents different process improvement initiatives focusing on specific business streams. The analysis presented here regards the design of a process model to support the XX alliance between Company B and one of its five major clients in the nuclear stream (Company X), and the design of a specific model, focusing on materials management on construction sites.

4.3.1 Implementation triggers

This section describes the reasons why Company B designed a process model to support the XX alliance, presenting the main drivers for implementation and expected benefits. The section concludes with a description of the XX alliance model as well as a description of the materials management model.

The alliance between companies B and X was initially proposed by Company X, as its construction division was experiencing great difficulties in delivering projects on time and to budget. As Company B has greater experience in managing projects and had business interest, the alliance was completed. It aims to achieve joint team working in delivering greenfield, brownfield and mixed projects\(^{22}\), appropriately using the skill set of each company and bringing good practices from both companies together.

A process model was designed with the aim of supporting the alliance, focusing on a specific operating unit from Company X, called T. T has been developing projects for

\(^{22}\) The projects costs in general are about £200 million.
more than 8 years with the involvement of 5 different contractors (one of them was Company B), each focusing on specific works, e.g. civil contractor, mechanical/piping contractor, electrical and instrumentation. Each contractor was working differently, to their own standards, and integration of the work was a major problem. Therefore, the decision to design the model was mainly focused on delivering the right organisation to improve the design and construction of Company X’s projects.

The process model was designed aiming at reducing or avoiding a number of problems. For instance, the design process was responsibility of both Companies B and X, and it involved a distributed design team. Major communications problems occurred due to the distributed team and the design management being shared by the two companies. Lack of control of the completion of design activities was also described. For example, in some instances the design team estimated that 90% completion, while the construction team estimated that only 60% of the necessary information was available. These problems generated rework, projects going over budget, with extended schedules, and being developed under time pressures.

Thus, the aim of implementing the model was twofold, i.e. support the alliance between the two companies and reduce some of the problems identified in previous projects with Company X, pulling design and construction together. A consultancy company was contracted to provide support for the process model design. The main drivers for the process model implementation are:

- to deliver the alliance, improving the collaboration between different contractors;
- to improve communication effectiveness and avoid rework / duplication of work;
- to appropriately manage knowledge, allowing lessons learnt to be transferred from one alliance project to the next;
- to allow the understanding of ‘good practice’ in Company B and the client; and
- to deliver projects on time and within budget, focusing on client’s needs.
The drivers for the development of the specific materials management model, which is part of the XX alliance process model, was to determine where problems in materials management were happening and propose new process activities and controls to avoid problems and reduce the ‘blame culture’ existent between expeditors and material controllers.

**Expected benefits of using the process model**

Company B expected to achieve different benefits from the implementation of the process model. As this initiative focused on the nuclear business unit as opposed to the whole organisation, the only benefit at the Company B’s organisational level was to support a specific contractual arrangement. In terms of the benefits expected to the process itself, the following were identified:

- establishment of joint teams with the client;
- improved communications through the use of integrated project management tools, reduced rework and more accurate information through project reviews;
- definition of activities, who must be involved with them, and the value added by getting those people involved;
- improved budget management over time and proactive control; and
- adoption of performance measures within and between projects (key performance indicators – KPIs);

Finally, from the clients’ perspective, the aim was to achieve projects delivered on time and to budget. Therefore, some of the benefits identified in the literature (see section 2.2.4) were similar to the expected benefits in Company B. All espoused benefits for the process itself described in the literature were also identified at Company B. For the client, better product quality was not considered as an issue, as the focus of the alliance was on managing the process as opposed to improving the quality of end products.
In summary, the main triggers for designing and implementing the model in Company B were to provide a framework for the alliance, and at the same time reduce the occurrence of problems such as rework, allowing the use of KPIs and enabling process control.

**Process model description**

This section briefly describes the XX alliance process model. Previous to that, the concept of a generic process as approached by the interviewee is discussed.

The interviewee described a generic or high-level process model as being the stages of a project, see Figure 4.10. It can be observed in the figure that great importance is placed on total risk management, performance measurement and the use of integrated project management tools as means to improve and control projects. Those were described as ‘ongoing processes’ occurring throughout the lifecycle of any project. Also, those were the key principles of the XX alliance model, e.g. managing risk not only until the approval to proceed (after conceptual design) is achieved, but throughout the whole process, as well as using performance measures and integrated project management tools.

![Figure 4.10: Project process in Company B](image)

It is interesting to note that the interviewee referred to the project stages as a ‘generic process’, without considering that a generic process should also include the different functions and main sub-processes. This demonstrates a lack of clarity with regard to the concept of a generic process model. This can lead to questions about such understanding.
in the company as a whole, if one considers the position of the interviewee in the company as process improvement manager. A further problem relates to a lack of consensus with regard to project phases themselves, which is evidenced by comparing the description of the project phases given by the interviewee (Figure 4.10) and the stages represented in the XX alliance model (Figure 4.11).

The model designed for XX alliance encourages a holistic approach to the process, dividing the whole process into a set of phases. The model is generic only for the alliance projects, and it can be classified as a ‘to-be’ model (see section 2.2.3), presented in Figure 4.11. It describes five project phases in its horizontal axis, and nine functions in its vertical axis. Under each phase there is a number of activities with clear inputs and outputs, and links between activities developed by different functions are represented. Procedures and work instructions were also included. The activities have been omitted from the figure for confidentiality reasons.

![Figure 4.11: Project process in Company B for XX alliance](image)

Project reviews are defined, but are not attached to the end of each project phase. Instead, they are linked to a number of senior management meetings through which ‘approvals to proceed’ are granted. Those meetings can be of two types, i.e. internal reviews,
developed by the project team itself; and, independent reviews; performed on a monthly or bimonthly basis by project managers who are not part of the alliance. These external managers meet with project managers involved in the alliance to discuss project problems and propose strategies to keep the project to budget and schedule.

The agenda for project reviews includes the following: (a) safety, health and environment issues; (b) design progress or construction progress; (c) commissioning progress; (d) financial review; (e) status of supply chain activities; (f) status of risk actions (considering what business risk Company B has and what project risk Company X has, as they could be different); (g) HR – human resources; (h) status of quality management activities; (i) status of key performance indicators; (j) improvement activities; and, (k) sharing “lessons learnt” across projects.

In addition, the model focuses on linking the design and construction phases. The construction work packs are defined based on a group of design deliverables, and construction should only start after all deliverables are available, materials purchased and people assigned for the job.

The model presents a continuous improvement aspect to it, as a major review is set at the outset of each project aiming to allow the gathering and sharing of knowledge across different projects. However, no guidelines for implementation are presented.

The management of the materials purchasing is a complementary part of the XX alliance model, being presented in Figure 4.12. It represents the process through a set of phases which are different to the generic phases in the XX alliance model. It also presents functions (i.e. materials) described alongside documents to be produced (i.e. information) and people to be consulted throughout the process. In this sense, it argued that the model lacks clarity with regards to its representation. Also, the link between the generic alliance model and the materials model is not clear, as they were designed to dissimilar standards, with stages and functions being represented differently.
4.3.2 Implementation outcomes

This section describes the implementation outcomes as perceived by the interviewee in Company B, as well as the main reasons identified for implementation failure.

At Company B, the process model implementation was unsuccessful. The main objective of devising the process model was to provide a framework to deliver the alliance. Accordingly to the interviewee, the idea of sharing best practice between the two companies has not been appropriately adopted by any of the companies, and the alliance was suffering as a result. The main reasons described relate to cultural problems and resistance to change.

The alliance was agreed between higher managerial levels between the two companies, with no consultation of middle managers, and this generated resistance to change in both companies. On one hand, Company X middle management (i.e. project managers) were used to dictate how the contractor (Company B) should operate. Due to the alliance and imposition of the process model use, such middle managers perceived to be losing power...
over the contractors, and that generated an environment of mistrust between the middle managers of both companies. On the other hand, Company B middle managers had different perceptions with regards to what constitutes good practice, and therefore different managerial principles were applied by different managers to develop projects. This approach was not considered appropriate by Company X, as the idea of the alliance was to adopt consistent procedures to manage all projects.

Another factor that hindered implementation was that as a result of the alliance and of the model design, the number of people involved on the projects was reduced, and that had a negative effect in terms of people feeling de-motivated and threatened. The fact that the alliance operated through risk-reward contracts also hindered implementation, as both companies were sharing the risks of the contract and could not work seamlessly due to the cultural problems mentioned earlier. As stated at interview 3, ‘different cultures need to be pulled together for this to work, and the different cultures are not varying’.

A further reason for the lack of implementation success was related to the excess and lack of clarity of guidance documentation. Company B had a number of different documents that should be used to support project management, i.e. the process model (which defines activities and procedures), project management guidance documents (which gives guidelines for the definition of project execution plans), and a quality plan. All these different documents present guidance which sometimes is duplicated and sometimes is divergent, and there is no clarity on how those could be integrated.

Even though the model uptake was not considered successful, parts of the model were being used, i.e. project reviews. Benefits accruing from reviews were described as reduced rework especially during design and the possibility of proactive control by middle managers. A further issue that was pointed out as a benefit from the model design is that it made explicit the gravity and importance of cultural issues in delivering the alliance between two companies which had a previous client-contractor relationship.
The level of detail through which the model was presented was not identified as a factor influencing implementation. This may be the case due to the fact that the model was not considered over detailed, but not enough evidence has been collected to support this proposition.

4.3.3 PDP model content evaluation

This section presents the evaluation of the process model content with a view to its implementation, using the framework presented in Figure 4.6. The XX alliance model content has been evaluated both in terms of the model applicability and usefulness at the company level. Table 4.2 presents the sources of data used for the evaluation, based on the interview transcript (extracts are presented to support the arguments being made) and on the researcher’s assessment of the model (e.g. assessment of the clarity of the model’s presentation structure).
## Table 4.2: Model evaluation with a view to its implementation in Company B

<table>
<thead>
<tr>
<th>Headline criteria</th>
<th>Attributes</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flexible?</strong></td>
<td>Generalisable to different areas</td>
<td>The model is not generalisable to different business areas; it was developed only for the XX alliance projects.</td>
</tr>
<tr>
<td></td>
<td>Updated regularly</td>
<td>The process model has been updated in the past, but there is no strategy in place to do so continuously.</td>
</tr>
<tr>
<td><strong>Easy to use?</strong></td>
<td>Presentation and structure (simple and clear)</td>
<td>The presentation of the model is clear and simple. The structure of the generic process model can be easily understood, being presented in an A3 size page. Procedures and working instructions are presented in a manual. No comments were made in the interview with regards to the simplicity of the process model.</td>
</tr>
<tr>
<td><strong>Clarity of the model content</strong></td>
<td>The content of the model itself is considered to be clear, but lack of clarity with regards to the relationship between the process model and other guidance documentation of the company was identified.</td>
<td></td>
</tr>
<tr>
<td><strong>Credible?</strong></td>
<td>People believes it helps management</td>
<td>The process model was perceived as credible by the interviewee; nonetheless, this may be a biased view as the interviewee is also one of the main developers of the model:</td>
</tr>
<tr>
<td><strong>Applicability</strong></td>
<td>Provides for scenarios and discussion of problems</td>
<td>The model provides forums for discussion of problems thought the project reviews.</td>
</tr>
</tbody>
</table>

Key: high, medium, low

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‘inverted commas & italics’: extracts from interview transcript

- ‘(Company B) haven’t got a generic process map as such, but we focus down into work execution areas; we have the alliance process, that we use to improve engineering’
- ‘we are not happy with it, we are challenging the model constantly’
- ‘…and that’s been a generic document that has been continuously amended to reflect best practice, and because of that we have to continuously go back and review it.’
- ‘…the organisations had different processes, so we when back, and set what a construction process has got to be and what the organisation should deliver…’
- ‘(Company B) have an intranet site of best practice so one of those things is project management; and we have a project management guide, so we are bringing that to (company X)’ - but not as part of the process model
- ‘we came to this partnership … without that, and if the process (model) were there before we even started to agree on how we are going to manage projects, that we would have been really good, to have a consistent approach’
- ‘now we’ve got one organisation with a process delivering the organisation, and not the other way around.’
- ‘the concept is great, but the reality doesn’t work the same because what we’ve got is the people at middle management … they have been used to work in this client contractor relationship, they were dictating to the contractor how to operate. So, to them, it’s a cultural change. They perceive to be losing power, it doesn’t suit heavily with them, so we are in an environment of mistrust…’
- ‘…project reviews, so independent people form the organisation … come together with the project manager and key people in his team and discuss what the problems are and how can we, as independent people, help you undertake your project and execute your project to cost and schedule’
### Credible?

Model role agreed

The role of the process model does not appear to have been clearly defined or agreed within the company. The focus was on delivering the alliance, but how the process model would support the alliance was not clearly established. The model is supposed to be used as a basis for planning the projects developed by the alliance, and it has not been effective as such. Furthermore, middle managers were not involved or consulted during the model design.

> ‘that’s the planning side (the generic model), but how can we work it down into detail that’s to the disciplines’
> ‘the process, it isn’t working, and that’s, the secret, that’s what we are doing at the moment, trying to improve the current situation. We identified that we have a lot of rework, and we are going over budget, with schedules extending, because we haven’t got the time between design and construction, so what we are doing is these activities to pull them together’ (referring to construction planning pulling information from design, but this is not explicit in the process model itself)

### Valid?

Applied in pilot implementation

No pilot implementation was done in the company. The model was designed and then published as a reference document.

Appropriately describes process

Both as-is process activities and improvements proposed (through the inclusion of new process activities in the to-be model) are described in a generic form. Process reviews are predicted but when they should occur is not clearly presented in the process model.

### Measurable?

Performance indicators

Performance indicators were developed as part of the materials procurement process model:

> ‘… and then we did get KPIs to measure how well the material process was working, and we gather information on process actual times, to get to know if we had problems’

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<thead>
<tr>
<th>Headline criteria</th>
<th>Attributes</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credible? Valid?</td>
<td>Model role agreed</td>
<td>‘inverted commas &amp; italics’: extracts from interview transcript</td>
</tr>
<tr>
<td>Valid?</td>
<td>Applied in pilot implementation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Appropriately describes process</td>
<td></td>
</tr>
<tr>
<td>Measurable?</td>
<td>Performance indicators</td>
<td></td>
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Chapter 4: Research findings: preliminary case studies
The concept of applicability is evaluated considering the model flexibility, its ease of use, and credibility. The alliance model is not flexible enough to be applicable to different business streams of the company, as it was not developed with that purpose. Flexibility in terms of the number and content of the process phases, roles and deliverables so that the model can be adapted to the project in hand is not a feature of the model, nor was described as important in interview 3. On the other hand, the model is flexible in the sense that it has been updated to reflect ongoing business changes.

The model has a clear and simple structure, presenting proper knowledge codification through a set of principles and practices. Nonetheless, as stated in section 4.3.2, the relationship between the model and other guidance documentation is not clear. Therefore, even though the model itself can be considered easy to use, the lack of clarity with regard to other guidance hampers its ease of use.

This contributed to a poor user acceptability of the model. Accordingly to interview 3, the model was considered credible by its developers, but the level of user acceptability is low. Middle managers, especially from Company X, had a high degree of conjecture on the utility of the process model, as they did not believe the model to be helpful. Another factor that might have contributed to the poor level of acceptability of the model was the lack of clear definition of the model’s role in the company.

Validity and measurability are further criteria to assess the model importance and usefulness in the company. The XX alliance model can be considered valid in terms of adequately capturing the actual state of the process, and appropriately describing the changes to be introduced. On the other hand, the model was not piloted and therefore it had not been validated through real life use. Finally, the model presents performance measures, but there was not enough information available in the interview or documents analysed to support the effectiveness of the use of the proposed measures.
4.3.4 Discussion: research hypotheses H1 and H2

The data presented and analysed here provide support for the research hypothesis 1: \textbf{H1}: 
\textit{Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful.}

Even though project reviews were adopted in the alliance projects, the implementation of the model as a whole was not successful. The evaluation of the process model demonstrated that it had shortcomings both in terms of its applicability and its usefulness.

Flexibility was not a feature of the process model, and it was approached as a ‘planning and control’ tool. Although it had a simple and clear structure and content, it can not be considered applicable as it lacked credibility. Middle managers from Company X did not support the model use as it imposed a perceived decrease on their bargaining power over the contractors. Furthermore, the model’s usefulness in the alliance was hindered by the lack of user acceptance, as well the fact that the model was not validated through pilot implementations.

The analysis of the data from Company B does not provide enough evidence to support or refute the research hypothesis 2: \textbf{H2}. 
\textit{Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use.}

Even though the model presented performance measures aiming at clearly demonstrating the improvements to be achieved by the process model use, the effectiveness of such measures, their actual use in practice, and the effects they had on the success of implementation could not be identified in the information available in this case study. Therefore, there is not enough evidence to support or refute this hypothesis.
4.3.5 Implementation process

The strategy and steps done to design the XX alliance model are described in this section. The description focuses on the process model design as no strategy for implementation has been identified. The process model had been designed six months prior to the interview. Six major steps for designing the model were identified in the interview, presented in Figure 4.13.

The first step in the model design focused on identifying the problem that the process model should support resolving, e.g. increasing teamwork and reducing rework, and therefore a business case for the process model design was proposed. This was done by top management from both Companies B and X, and the decision to involve a consultancy company as an external body to support the process model design was then taken. The second step involved the identification of current activities and responsibilities, and the business service manager was responsible for that.

Following, a team was defined to design and implement the process model. The consultancy company demonstrated the need for having a team responsible for the model design and for engaging middle managers with the model use. The interviewee was appointed as the team leader, and the team was comprised by three other project managers, and one external consultant.

A more detailed analysis of the process was then conducted, aiming at identifying the ‘as-is’ process as well as better approaches to manage cost, time and people. The team carried out a number of interviews with project managers involved in the process, and improvement guidance was defined as a result of the interviews. The main issues analysed included: (a) who was involved in executing work from each of the five
contractors and how; (b) coordination; (c) risk management; (d) human resources; (e) planning and estimating; and, (f) cost management. The analysis and key improvements to current practices proposed was registered in data sheets. An example is provided in Table 4.3.

Table 4.3: Example of data sheets with key improvements to be included in the process model

<table>
<thead>
<tr>
<th>no</th>
<th>Improvement description/area</th>
<th>Benefits</th>
<th>Barriers to delivery</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Integrated Management System</td>
<td>• Address issues around lack of visibility of the current procurement</td>
<td>• Resistance to change, control deemed to be relinquished</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1 Revisit current procurement strategy, amended as necessary and roll-out to all affected</td>
<td>strategy</td>
<td>• Interim arrangements may be required with what was the Company B badge companies until strategy is</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Action party: D. K.</td>
<td>• Ensure that all buy-in to strategy and alignment of the disciplines</td>
<td>fully implemented</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Opportunity to address recent organisational changes within Company B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>at corporate level</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The process model was then designed through a group of six workshops in which the external consultant acted as a facilitator. Procedures and working instructions were developed partially by the design team and partially by the consultancy company, mostly based on early documentation from Company B. The model design took six months to complete. However, no strategies to motivate future model users were considered during the model design.

A programme of key deliverables was also devised, including the following activities:

- mapping of the existing organisation and process; challenge current arrangements; design new organisation; populate the organisation using SWOT (Strengths, Weaknesses, Opportunities, Threats); Manage change and HR;
- estimates/planning: map out existing processes; review design/agree new processes; produce procedures and work instructions;
- efficiency: identify KPIs; compare against other projects; develop data sheets; develop process managing information;
• integrated management system: develop vision and strategy; develop implementation plan; identify procedures and populate; identify work instructions and populate; and

• re-alignment: confirm new organisation has been populated; training needs and competency values identified; develop improvement plan (next set of deliverables).

Furthermore, common systems to gather information and key performance indicators were also developed. Headline, project and operational KPIs were developed for the alliance. Headline KPIs follow: (a) achievement of cumulative estimated costs; (b) cost and schedule predictability; (c) compliance site standards (safety, quality and behaviour – nuclear site restrictions); (d) employee contribution to value; and, (e) customer satisfaction.

4.3.6 Discussion: research hypotheses H3 and H4

The data presented in section 4.3.5 provides support for the research hypothesis 3: **H3:** Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation and adoption does not occur.

Process model adaptation did not occur at Company B. Even though the model is specific for the alliance projects, there is still great variability between them, which require a certain degree of adaptation so that the model can be applied to the project in hand. However, the model was not adapted for the project level, and this blocked its implementation.

The need for a process model to support the alliance was defined, and as a result the process model was designed. However, the only part of the model that was adapted to the projects and used were the project reviews. Therefore, it can be argued that the process
model design was not effective in unfreezing the current state, as the future users of the process model (i.e. project managers) were consulted but not effectively involved in the process model design. As the current state of the process did not ‘unfreeze’, the process model could not be implemented.

Data also provides support for the research hypothesis 4: **H4:** *Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP implementation and replication when compared to companies where future users do not participate in the model development.*

In Company B the process model was not developed in full collaboration with its future users. Users were consulted for the identification of the as-is process as well as the main process problems, but they were not involved with the process model design. Users were not motivated to use the model as they perceived it as a threat to their power over the process. Therefore, they did not have individual interest in taking actions to implement the model, and chose not to use it.

### 4.3.7 Implementation content: factors affecting implementation

The factors affecting implementation in a positive and negative way in Company B are described in this section. Drivers, enablers and restraining forces where classified according to their influences over the triggers, process model content, implementation process and outcomes, as presented in Table 4.4. The table demonstrates a great focus on people issues, as most factors identified relate to resistance to change, cultural differences, and people being able (or not) to understand the benefits of change. The importance of the implementation strategy is also clear, as many enablers (both realised and perceived) relate to issues such as definition of the programme deliverables, leadership and making information available to all.
Table 4.4: Factors affecting implementation triggers, content, process and outcomes in Company B

Key: all information is from interview 3; factors perceived as important by the interviewee have been included (presented in italics), even though they have not effectively influenced implementation.

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Triggers</th>
<th>Content</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events that accelerated decision to implement</td>
<td>Why? Objectives</td>
<td>Improvements</td>
<td>Steps, Strategy</td>
<td>Why success/failure</td>
</tr>
<tr>
<td>Made it quick</td>
<td>Benefits</td>
<td>Model content</td>
<td>Guidelines; TT</td>
<td>Benefits achieved</td>
</tr>
<tr>
<td>• alliance between contractor and client</td>
<td>• alliance between contractor and client</td>
<td>• lessons learnt available before project starts</td>
<td>• clear team organisation</td>
<td>• no evidence</td>
</tr>
<tr>
<td>• communicating benefits of change</td>
<td>• lessons learnt available before project starts</td>
<td>• clear team organisation</td>
<td>• consultancy company support</td>
<td></td>
</tr>
</tbody>
</table>

| Enablers | | Process | | |
| Allowed or facilitated change made it easier seem more appropriate or more achievable | | Steps, Strategy | | |
| Made it quick | | Guidelines; TT | | |
| • holistic project view by all | • project reviews enabling proactive solution of problems | • definition of key deliverables: model design/implm. | • analysing value added by the model |
| • process analysis from high-level through to detailed procedures | • common information systems / management tools between client and contractors | • making information available – publishing the model | • monitoring through KPIs |
| • process guides in a user friendly format | • having resources | • phased implementation | |
| • defining inputs and outputs | • phased implementation | • involving all in implementation | |
| • defining process deliverables | • defining training needs | • identifying training needs | |
| • definition of key deliverables: model design/implm. | • re-align the process when needed | • making information available – publishing the model | |

The driving factor affecting the implementation triggers was clearly defining the need for the alliance coupled with an understanding of the benefits of having a process model to support the alliance. Unfortunately, such understanding was clear at the higher managerial levels and within the team that designed the process model, but not by the future model users, which negatively influenced implementation. Achieving a holistic process view by all project participants and the need for comprehensive process analysis were identified as factors enabling implementation triggers.

The main driver influencing the definition of the process model content was the process model making lessons learnt from previous projects available to project managers as a means to improve design and construction. A factor that made implementation seem more achievable was the incorporation of project reviews, which would create a forum
for discussion and therefore allow the proactive solution of problems throughout the process. The adoption of common information systems between the alliance companies could simplify and increase information exchanges between project stakeholders, and therefore it was identified as another enabler. Finally, presenting the model in a user friendly format and clearly defining inputs and outputs of process activities also facilitated the model use. Factors related to the process model content restraining its use were restrictions of working in a nuclear site, as these could not be predicted. Consequently, project variability was a force restraining implementation.

With regard to the implementation process, only factors affecting the process model design were identified, due to the fact that the model was not effectively used in Company B. The factors driving the model design related to establishing a team which had responsibility and ownership for the model, and the support of an external consultancy company. The team was also expected to drive the use of the model, but that did not happened due to difficulties in achieving buy-in as well as due to the perception of loss of power by Company X middle managers. The fact that the model has not been piloted also generated barriers due to lack of user acceptability (see section 4.3.3). Further factors facilitating the model use were establishing a programme of key deliverables, as well as making information available to all by publishing the model both on-line and through hard copies. Having human and financial resources available for the model design were further enablers.

Activities perceived to enable the model implementation (presented in italics in Table 4.6), relate to the need of determining a phased implementation strategy, which should consider the gradual introduction of changes, with a greater focus on involving people with the model design and implementation plans, as well as the identification and delivery of training needs. The importance of keeping the model updated and aligned to the culture of both companies was also emphasised. Clearly defining the value added by the model to the alliance was perceived as an enabler, but value needs also to be determined for project managers from both companies for motivation and to avoid resistance to change. Finally, monitoring performance through the use of key
performance indicators to clearly demonstrate benefits to all in terms of reduced costs and attainment to design and construction schedules were emphasised. The forces restraining success were twofold, the lack of alignment between the culture of the contractors and client, which was not appropriately considered; and, the constant need for re-designing the model to adjust it to the alliance needs, which were highly variable.

Figure 4.14 describes, in a graphic format, the relationship between the implementation actions and the main driving and restraining forces acting upon the process model implementation in Company B.

![Diagram](image-url)

- = driving force; = proposed actions; = Restraining force

**Figure 4.14: Implementation actions, driving and restraining forces in Company B**

Implementation difficulties at Company B were classified accordingly to the measures of stickiness (see section 2.5.4) as follows:

- project managers had varied degrees of conjecture over the utility process model. Thus, unproven knowledge occurred;
- lack of motivation from middle managers to adopt the model occurred as a result of perceived associated loss of bargaining power;
- barren context was identified through variability in the alliance aims requiring constant redesign of the process model;
- conjectures over the utility of the model occurred as it has not been piloted, which generated buy-in difficulties; and
- Company X members perceived the process model and the information used to build it (practices from Company B) as not reliable.

Other measures of stickiness were not identified in Company B, i.e. the process model content was not identified as ambiguous, the communications between model developers and users did not appear to be problematic, the process model developers were motivated, and the model users appeared to have appropriate absorptive capacity.

### 4.3.8 Discussion: hypotheses H5 and H6

The data presented in section 4.3.7 provides support for the research hypothesis 5: **H5**: *Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy.*

In Company B, process knowledge was explored by the model developers, but not by its potential users. As identified in Company A, exploitation is more likely after a certain degree of exploration happened. As users did not explore and experiment through the process model design, they also did not exploit the knowledge expressed within the model.

The transmission of the knowledge embedded in the process model was done solely through the model publication in Company B. This has proven not to be a suitable strategy as process knowledge did not produce the desired changes in the actions or behaviour of project managers. Therefore, it appears that the company did not place the necessary importance for the transmission of knowledge from model designers to users.
Furthermore, factors affecting the transmission, absorption and use of the process model have been tacitly identified. However, such factors have not been appropriately managed as part of the implementation strategy. For instance, the negative effects of the fact that people could not perceive the benefits accruing from the model implementation were identified early on, but no actions (for instance workshops or focus groups) to evaluate the model and make its benefits explicit to users were put in place at any point in time. Therefore, as in Company B the factors affecting the model use were not managed and implementation was not successful, support is given for H5.

The data gathered at Company B does not provide enough evidence to support or refute hypothesis 6: **H6: Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects that companies in which generic model is not continuously and explicitly updated.**

The need and importance of updating the process model to adapt to business changes and to reflect specific experiences and good practices in its application were issues emphasised at Company B. In fact, the model has been updated in the past, but not with the basis on past experience of its use, as it has not been successfully applied. Also, there are no continuous improvement strategies in place supporting the model updating. Therefore, as the model update was not based on its specific application at projects, the hypothesis cannot be supported or refuted. Only indicative support for the hypothesis is given due to the importance placed on the model’s constant update.

### 4.3.9 Summary of key findings

The main drivers for designing and implementing the model were to provide support for the alliance between companies B and X, improve communications, avoid rework, appropriately manage knowledge and lessons learnt between projects, enable process control, and make ‘good practice’ available to deliver projects on time and to costs.
The outcomes of implementation were unsuccessful, mainly due to cultural differences between the two companies, and resistance to change. Lack of definition of the benefits for the model users, lack of involvement of users during the model design, perception of the managers to be losing bargaining power due to the model use, mistrust between middle managers from both companies, and divergent perceptions on what constitutes ‘best practice’ were the main barriers to implementation.

The knowledge content of the process model also negatively influenced its use. The process model cannot be applied throughout the company as it is specific to the alliance projects, and it has not been validated. Also, there is a poor definition of the model’s role, which focused on supporting the alliance, but how such support is provided is not defined. Also, the model has been approached as a planning and control tool, which should link design and construction planning, but how this could be done is not defined in the model.

The company has not formulated a strategy to support the use of the model, therefore only the steps taken to design the model were identified. These included identification of problems, process analysis, model design and definition of procedures. Due to the problems above mentioned, the model was not adapted to the project contexts and not used to guide actions of the project team.

Finally, the factors affecting implementation both negatively and positively were tacitly identified, but not systematically described or acted upon. The identified factors focus mainly on people issues, and on the importance of having a clearly established implementation strategy.

The next section presents data gathered and analysed for Company C.
4.4 Preliminary case study: Company C

Company C is a defence and aerospace company with international reach as a prime contractor and systems integrator in the air, land, and sea defence market sectors. It develops naval platforms, military aircraft, electronics, systems integration, and others. The construction division of the company was involved in the study, being denominated ‘Infrastructure Solutions’.

Infrastructure solutions is responsible for planning, developing and managing all new buildings, demolition and refurbishment of Company’s C buildings. It is responsible for forecasting building needs, developing feasibility studies and planning, designing, constructing, managing the projects as well as for facilities management.

Company C had recently designed a generic, high-level process model, which was to be piloted in five projects in a short period after the case study took place. Thus, the description presented here relates to the model design and pilot implementation plans.

4.4.1 Implementation triggers

The decision to design and implement a generic process model in Company C was related to the establishment of partnering agreements with five major construction contractors in the UK. The objectives of partnering were to reduce tendering costs and improve the process. The expected savings were predicted to be around £4.9 million per year in the first, second and third year of the partnering. Therefore, the process model was conceived as a framework to support process management between Company C as the client and its partners.

The decision to design a process model to better manage the construction projects was also done as process management in general is well embodied in Company B’s culture, excluding its construction area. Therefore, the company high management impinged the...

---

23 Costs in excess of £100M/year, spread between fifty to sixty projects per year.
need for improvement in construction through better process management. The process model was defined as a document that would describe the company’s philosophy for project management, and that would have to be respected by all partners.

**Expected benefits of using the process model**

Time and effort were invested in the design and implementation of the process model within Company C to achieve different benefits, the overall aim being to allow the improvement of design and construction management. Benefits were identified for the company as the construction client as well as for the project level. The main organisational wide benefits were identified as:

- savings in terms of time and financial resources in tendering;
- the model should allow all company’s projects to be developed in a similar way;
- the model should be used to train project managers (existing and new employees) to be involved in the projects developed between Company C and its partners; and
- the model was perceived as being a driver of change in the construction industry and, therefore, measurement was essential;

The following benefits for the project level were identified:

- having process information available in a simple and user friendly format, which is ‘live’ and therefore permits continuous improvement;
- having predefined information needs for each stage available to allow reviews;
- enabling proactive control over project finances;
- proactive control through better planning and performance indicators;
- integration between the teams developing the project;
- the model should help avoid duplication of work within projects; and
- the model should support cost savings through value engineering.

Therefore, the main focus of the initiative was on supporting the new contractual arrangement (partnering) and reducing costs. Issues such as improving competitiveness...
were not mentioned as Company C is a client organisation. Once again, improving the product quality was not perceived as a benefit, but the focus was rather in applying value engineering to achieve appropriate cost/benefit solutions through suitable design solutions.

The benefits for the process itself were very similar to the espoused benefits identified in the literature (section 2.2.4), i.e. less time and costs through better planning, reducing errors and rework and benchmarking for continuous improvement. Improving communications thought the use of model was not mentioned directly, but indirectly through improving teamwork and having information needs specified. Benefits identified in Company C and not emphasised in the literature include the focus on value engineering and proactive financial control.

In summary, the main triggers of process model implementation in Company C were to support the delivery of partnering agreements, improve process management enabling project reviews and proactive process and financial control.

**Process model description**

Process improvement in Company C has been proposed through the design and implementation of the model denominated ‘Construction Process Plan’, presented in Figure 4.15. The model encourages a holistic process approach, being a ‘route from concept to completion’ describing the process through a set of seven phases, i.e. planning, strategic construction partner selection (which is a separate, supporting process), approval, outline design, detail design, construction, and post handover. Under each phase there is a number of high-level activities defined, along with decision points, the participants of each activity, main inputs and outputs in terms of information, major project milestones (linked to payments to the partner) as well as a number of project reviews. Therefore, the model can be classified as a ‘to-be’ high-level model (see section 2.2.3). Differently from the models of the two previous case study companies, this model does not describe the functions which should be responsible for the activities in its horizontal axis, but it links the description of responsibilities to the process activities.
Most of the activities in the model represent the work that must be done by Company C as client and higher-level manager of the design and construction process. Thus, focus is given to planning and control over the contractors’ activities, verifying business needs and determining project requirements and necessary or available budget. Company C provides the contractors with the business case and project brief, and they expect them to develop ‘sensible and cost effective solutions’ based on it. Contractors and designers are expected to determine a detailed project plan accordingly to the generic process model. Additionally, a great emphasis is given to the project approval process, which is presented as a whole stage in which the development of the business case and project brief is done.

Project reviews are not attached to the end of each project phase, nor are they defined as soft or hard gates (see section 2.2.5). These are based on the completion of a pre-defined set of information along the process. Most reviews represent formal stop/go decision points, i.e. the project can be stopped for redevelopment until it achieves the expected level of information or performance. Nonetheless, design reviews are considered ‘softer’ reviews, as they do not constitute a ‘stop’ point but rather a point of evaluation and refinement. The stakeholders that need to take part on the reviews are determined, and
there is also a review board which, in general, is independent of the project. The phase reviews are milestones in which project improvement opportunities should be identified.

Two phase reviews are predicted in the project approval phase, being one related to the analysis of the project brief and the second to the mobilisation to start the project, which happens after the selection of the partner for the specific project. There is also one phase review predicted in the outline design stage and one during detail design.

The activities concerning design development are not specified in the model, which is also true in relation to construction activities. In the construction stage, one review is defined before the facility handover, and in the post handover stage there is a final review in which customer satisfaction is assessed. Furthermore, the model did not present an explicit set of key principles, nor described guidelines of how it should be implemented.

### 4.4.2 Implementation outcomes

As stated previously, when the case study took place the process model design had just finished and there were plans to pilot implement it in five projects. Therefore, it was not possible to assess implementation outcomes in Company C. Nonetheless, the interviewees described a number of problems occurring during the model design, which are described in section 4.4.7.

### 4.4.3 PDP model content evaluation

This section presents the evaluation of the process model content with a view to its implementation, using the framework presented in Figure 4.6. The process model has been evaluated in terms of its applicability and usefulness. Table 4.5 presents the sources of data used for the evaluation, based on the interview transcript (extracts are presented to support the arguments being made) and on the researcher’s assessment of the model (e.g. the assessment of the clarity of then model’s presentation structure).
### Table 4.5: Model evaluation with a view to its implementation in Company C

<table>
<thead>
<tr>
<th>Headline criteria</th>
<th>Attributes</th>
<th>Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flexible?</strong></td>
<td>Generalisable to different areas</td>
<td>‘inverted commas &amp; italics’: extracts from interview transcript</td>
</tr>
<tr>
<td></td>
<td>Updated regularly</td>
<td>The model is high-level, and is supposed to be used for all projects developed in Company B. Therefore, it is generalisable for all different types of construction work done by the company.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>‘In different parts of the company we do our work in slightly different ways so there will be different words and different titles for certain tasks, but the general main elements will happen’.</td>
</tr>
<tr>
<td><strong>Easy to use?</strong></td>
<td>Presentation and structure (simple and clear)</td>
<td>The model is supposed to be updated accordingly to information collected at the outset of projects:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>‘it will be a live process, because when it is in the internet site it will be easy to update and make modifications. At the end of the project we have this post-handover review phase ... they should collect comments and modify the process accordingly, so it should be a live document, otherwise it won’t work properly’.</td>
</tr>
<tr>
<td><strong>Applicability</strong></td>
<td>Clarity of the content</td>
<td>The model is presented simply and clearly, in an A3 size sheet, and each phase is then detailed in one single page. The flowchart structure can be easily understood. The only part of the model with could be improved in terms of the clarity on its representation regards the involvement of each stakeholder in process activities. This is represented within the detailed activities. Therefore a certain amount of ‘reading’ is needed before one identifies responsibilities over the activities. The model was also to be further detailed and published in the company extranet in the future.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>‘What we intend to do is to produce some guideline documentation to go with this (the map). And then have that in the internet, so that you have the model in your internet page, and then you can have all these boxes here (process activities) as hot buttons to take you down to the detail of that particular phase or that particular activity.’</td>
</tr>
<tr>
<td><strong>Credible?</strong></td>
<td>People believe it helps management</td>
<td>The knowledge content of the process model is considered to be clear. Nonetheless, the language used allows for different interpretations of the process activities content.</td>
</tr>
<tr>
<td></td>
<td>Provides for scenarios - discussion of problems</td>
<td>It was not possible to assess if the model users believed the model helps management or not through the interview. Nonetheless, the importance and difficulties related to it were described:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(problem related to process implementation) is going to be, initially, convincing people that this process will work, and that this is the best process, and not the way they have always done it. I think that this is the most difficult one... I think it people don’t want it, implementation becomes very difficult’.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The model may provide for the consideration of different scenarios as well as for the discussion of problems and potential solutions through the project reviews, but the effectiveness of those could not be addressed as the model was not implemented.</td>
</tr>
</tbody>
</table>
The role of the process model in the company is clearly to serve as a basis for planning and as a guide for the definition of process activities. This role was not agreed throughout the company but it was to be imposed to users: ‘we actually used the planning stage to identify a number of pilot studies that can actually cast the model before we mandate it for the all projects, but we intend to – it will be mandated, within the company, for all projects over about £100 thousand’.

The process was to be pilot implemented in five projects: ‘The more we balance it, the more we can low it down to people, and the acceptance will be better. Not only because people have used it, but because we can say we have used this in real projects in Manchester, Scotland, etc, and it works’.

The model appropriately describes the ‘to-be’ process, but it is not possible to clearly identify which improvements were included with regards to practice that were adopted previously by the company as the ‘as-is’ model does not exists.

Performance indicators were included in the model: ‘we have both process and environmental performance measures, we have things like ”green assessment for design”, we are looking at things like ”number of scope of design changes” because we want to be able to feedback that information within the company’.

<table>
<thead>
<tr>
<th>Headline criteria</th>
<th>Attributes</th>
<th>Sources of data ‘inverted commas &amp; italics’: extracts from interview transcript</th>
</tr>
</thead>
</table>
| Credible? Valid?  | Model role agreed | The role of the process model in the company is clearly to serve as a basis for planning and as a guide for the definition of process activities. This role was not agreed throughout the company but it was to be imposed to users: ‘we actually used the planning stage to identify a number of pilot studies that can actually cast the model before we mandate it for all projects, but we intend to – it will be mandated, within the company, for all projects over about £100 thousand’.

The process was to be pilot implemented in five projects: ‘The more we balance it, the more we can low it down to people, and the acceptance will be better. Not only because people have used it, but because we can say we have used this in real projects in Manchester, Scotland, etc, and it works’.

The model appropriately describes the ‘to-be’ process, but it is not possible to clearly identify which improvements were included with regards to practice that were adopted previously by the company as the ‘as-is’ model does not exists.

Performance indicators were included in the model: ‘we have both process and environmental performance measures, we have things like ”green assessment for design”, we are looking at things like ”number of scope of design changes” because we want to be able to feedback that information within the company’.
The concept of applicability is evaluated considering the model flexibility, its ease of use, and credibility. Company C’s model is flexible and therefore it is considered to be applicable to the different projects developed by the company. Flexibility in terms of the number and content of the process phases was identified as necessary by the model designers, but flexibility in terms of roles and deliverables was not. Additionally, the model is flexible enough to be updated to reflect project practices and experiences through the final project review.

The model has a clear and simple structure, presenting proper knowledge codification through a set of practices. The definition of the information needs for each project review further clarifies the objectives and type of information that needs to be produced in each phase. Therefore, the model can be considered as easy to use and applicable.

The model credibility could not be appropriately assessed as not enough information on that was available. In any case, the interviewees pointed out difficulties with regards to the model users’ belief that it effectively described good practices. This gives an indication that there should be a certain degree of conjecture over the utility of the model throughout the company. This could have been caused also by the fact that the model had not been approved with the company higher management levels. Also, the fact that the model has not yet been validated through pilots could also have contributed to its poor acceptability.

Validity and measurability are further criteria to assess the model usefulness in the company. The model can be considered valid in terms of adequately capturing the actual state of the process, as it describes the ‘to-be’ process. Even so, it is not possible to clearly identify which improvements were included to current practices in the company as the ‘as-is’ model does not exist. Finally, the model presents performance measures, which have not been tested.

### 4.4.4 Discussion: research hypotheses H1 and H2

Data presented and analysed here do not present enough evidence to either support or refute the hypothesis 1: **H1: Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful.**
The process model devised in Company C appears to be generally applicable, as it is flexible and easy to use. Nonetheless, difficulties with regards to the model credibility were identified in terms of convincing people that the model truly represents good practices. The model is also considered useful by its designers, but the model role has not been agreed throughout the company, which can undermine implementation. Nonetheless, as the model has not been used prior to the case study, it is not possible to state if its use is effective or not.

Even though flexibility was a feature of the process model, it was approached as a ‘planning and control’ tool which was to become mandatory in the company after its pilot implementation and approval by the top management. These strategies were both ineffective in the case study Company A.

Company C’s case also did not provide enough information to support or refute research hypothesis 2: \( H2 \). \textit{Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use.}

The model presented performance measures aiming at clearly demonstrating benefits achieved through the model use both in terms of time and cost reductions. Even though the measures have not been used yet, it is possible to state that there is a great focus on the use of performance measurement as part of the process model implementation.

\textbf{4.4.5 Implementation process}

The implementation process identified in Company C relates to the strategies adopted for the process model design, as described in Figure 4.16. Activities related to the definition of the partnering agreements are presented as contextual information, and planned future activities are also described.

The process started with the decision to adopt partnering, which was taken because the company has large scale projects that can benefit from it. After the need and cost benefits of partnering were determined, the company engaged with the partner selection.
A set of criteria was determined to evaluate potential partners. The selection started with a desktop search, followed by the use of a questionnaire to collect information on potential partners. After that, a reduced number of companies was interviewed, and then the final selection of four major construction companies to become Company C’s partners occurred. The need for designing the construction process plan was realised as part of the partnering process.

![Figure 4.16: Company C’s implementation process](image)

A team was then composed to design the construction process plan, and both interviewees were part of it. Apart from designing the model, the team was also responsible for demonstrating to Company C’s top management the importance of the model and formulating and agreeing a design and implementation strategy with them.

The process model was designed through a series of review meetings carried out by the above mentioned team. After consensus was reached within the team, the model was presented to a larger stakeholder group, which would then discuss and comment about it. This larger stakeholder group included people from Company C as well as from all the selected partners. After the comments were gathered, a new version of the process model would be developed. Therefore, the model was developed through a number of cycles of design, discussion and refinement.
Chapter 4: Research findings: preliminary case studies

The presentation and discussion of the model content happened in different ways. In some instances there were formal meetings, and in others the model would be sent to stakeholders via e-mail for comments. When asked about how the model was developed, the interviewee mentioned: ‘this is about version number 93’ (Interview 4), which demonstrates the difficulties the team had in reaching consensus on the model content. This cycle of model design and refinement occurred through six months, and solely the high-level process activities were defined.

The process model was developed using different sources of information, i.e. the life cycle management model (Company A’s model), the design and construction process protocol, and the key performance indicators published for the construction industry by the Department of Trade and Industry (DTI, 2000). The model was also designed based on Company C’s own practices.

The next steps focused on future activities of the model design and implementation. These include the completion of the process model design, the definition of an implementation strategy and the implementation itself. The detailed activities level of the model still needed to be defined, as well as guideline documentation and procedures. When the model design is finished, it will be published in the company intranet. The aim is that each stakeholder could access detailed information by clicking into the high-level activities in the model, which would be ‘hot buttons’ in the intranet.

The interviewees could not provide detail on the implementation strategy as it had not been defined. Nonetheless, a new implementation team would be defined to be responsible for the projects performance, measurement, improvement and the model update. Such team would be composed by three people from Company C, and three people from each of the partnering companies. Performance would be measured in terms of time, cost, quality, user satisfaction and change orders.

Furthermore, the process model was to be pilot implemented in between four to six projects of different types developed in different locations in the UK as means of validation. The idea was that after the models was tested and refined, it would be mandated within the company for all projects over specific costs. The interviewees also pointed out their belief that the model would be better accepted in the company after pilot implementations. With regards to adaptation, it was stated (Interview 4):
'I think the detail to which it will be used will depend on the project itself. We expect ... every project go through the whole process, if it is a very small project it can go through development in a much faster way, ... we should not stop the project in any way apart from the gates'

Therefore, the need for adaptation regarding the characteristics of the project in hand was recognised. There was also a recognition of the need for adaptation to suit different business units of the company, i.e. ‘in different parts of the company we do our work in slightly different ways so there will be different words and different titles for certain tasks, but the general main elements will happen’ (Interview 4).

### 4.4.6 Discussion: research hypotheses H3 and H4

The data presented in section 4.3.5 provides indicative support for the research hypothesis 3: **H3**: Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation and adoption does not occur.

In Company C the process model has not been used, therefore it is not possible to evaluate implementation effectiveness. Nonetheless, the need for adapting the process model to suit specific business units and project needs were clearly acknowledged. In this way, it is possible to state that process model adaptation is perceived as essential to successful implementation.

At Company C’s superficial consideration was given to implementation during the process model design. The company defined the steps for the process model design and subsequently designed the process model, but the implementation strategy was to be formulated in the future, as a completely separate activity. At this case study, the effectiveness of the process model design in unfreezing the current state could not be addressed.

The data also provides indicative support for the research hypothesis 4: **H4**: Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP
implementation and replication when compared to companies where future users do not participate in the model development.

Once more it is not possible to prove or refute this hypothesis on basis of the information provided by Company C. Nonetheless, the process model was designed in collaboration with its future users, who were consulted for feedback during the model design. This was approached as a strategy to motivate users as well as to generate a higher quality model.

### 4.4.7 Implementation content: factors affecting implementation

The factors affecting implementation at Company C are described in this section. Drivers, enablers and restraining forces are presented in Table 4.6 accordingly to their effects over the implementation triggers, content, process and outcomes.

#### Table 4.6: Factors affecting implementation triggers, content, process and outcomes in Company C

**Key:** all information is from interview 4; factors perceived as important by the interviewee have been included (presented in italics), even though they have not effectively influenced implementation.

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Why? Objectives</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Made it quick</td>
<td>support for partnering</td>
<td>• all projects developed in similar ways, with same principles</td>
</tr>
<tr>
<td>Events that accelerated decision to implement</td>
<td></td>
<td>• not allow duplication of work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• clearly demonstrate benefits</td>
</tr>
<tr>
<td></td>
<td>Why success/failure</td>
<td>Benefits achieved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• no evidence</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enablers</th>
<th>Why? Objectives</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowed or facilitated change made it easier seem more appropriate or more achievable</td>
<td>designed through consensus</td>
<td>• flexibility to adapt to project characteristics</td>
</tr>
<tr>
<td></td>
<td>having KPIs</td>
<td>• training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• detailed information on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• pilot to validate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• publicise model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• mandate model</td>
</tr>
<tr>
<td></td>
<td>Why success/failure</td>
<td>Benefits achieved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• process should allow different cultures to merge (client/partners)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• detailed process planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• measure implementation success</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Restraining</th>
<th>Why? Objectives</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative impact on implementation</td>
<td>difficulties to clearly demonstrate benefits</td>
<td>• difficulties in sharing information</td>
</tr>
<tr>
<td></td>
<td>keeping expectations balanced</td>
<td>• convincing people that the process model works</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• confidential information</td>
</tr>
<tr>
<td></td>
<td>Why success/failure</td>
<td>Benefits achieved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• difficulties in working together; cultural differences and interests between companies involved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• people solving problems in their own ways</td>
</tr>
</tbody>
</table>

The importance of people issues both as enablers and restrainers of implementation is apparent in Company C. Most factors presented relate to resistance to change,
motivation, expectations, training, consensus, and clearly demonstrating benefits accruing from the model. Issues related to the process model content, such as the model representing a flexible map from concept to closure are also clearly important.

The factors that enabled the implementation triggers in Company C relate to making possible all projects to be developed accordingly to the same principles. Clearly defining and demonstrating the benefits that would accrue from the model use and the possibility of avoiding duplication of work in the company were factors that made implementation seem appropriate.

Nonetheless, difficulties in demonstrating benefits were pointed out. Not all projects will benefit in terms of cost savings, and ‘*some times it is difficult to demonstrate that there is a good reason why it did not materialised in major cost savings, but there are still some other benefits*’ (interview 4). A related barrier concerned keeping business expectations balanced with regards to implementation. The interviewees stated that there were high expectations within the business in terms of costs reductions, and there were concerns that if such cost reductions were not achieved, the model would be discredited.

One factor accelerating the decision to implement related to the model knowledge content was approaching the model as a ‘road’ map, which would allow the introduction of improvements and the documentation of good practices and lessons learnt. Further enablers were designing the process through consensus, by consulting people and incorporating different perspectives on the resultant model, as well as using KPIs. Factors having a negative impact related to the model content were difficulties in convincing people that the model works and represents good practices, as each company and each stakeholder tend to have their own beliefs with regards to what constitutes good practices. Difficulties in sharing information between the partners also represented implementation difficulties, as the partners were still under competition for Company C’s projects.

The definition of a team responsible for designing and implementing the process model was an event that accelerated the implementation process. Other enablers were the process model flexibility to adjust to the project context, as well as the model presenting detailed information on activities. Some factors were considered as potential enablers,
being described as the pilots, as they provided for the model validation, publicising the model in the intranet to make information available to all, and also mandating the model after its validation. It is interesting to note that in Company C mandating the model use was perceived as a potential enabler, whereas in Company A this was in fact a barrier.

The identified barriers to the implementation process were related to resistance to change. The model being seen as a solution given was pointed out, and even though users had been involved through consultation in model design it was perceived by the interviewees that they still did not develop sufficient ownership of the model. Differences on the language (i.e. meanings of words) used in different business units were also seen as potential barriers, as they could lead to misunderstanding of the model content. Finally, the interviewees described that the model should allow the different cultures of the partner companies to merge, supporting project planning and the measurement of project performance to enable successful implementation outcomes. Difficulties in working together due to cultural differences, divergent interests and personal beliefs, as well as confrontation between partners were identified as further barriers.

Figure 4.17 presents the relationships between implementation steps and the main driving and restraining forces acting upon implementation as identified in Company C.

Figure 4.17: Implementation actions, driving and restraining forces in Company C

Difficulties related to the implementation process are referred to as measures of implementation stickiness. As at Company C the model was not effectively used prior to the case study, only perceived measures of implementation stickiness were identified:
• difficulties relating to the ease of communication between the model developers and users were identified in terms of keeping expectations balanced throughout the company, as well as in terms of difficulties in sharing information;
• lack of motivation from the model user has been identified through potential barriers related to: (a) lack of buy-in due to poor involvement with the model design, and (b) users solving problems not considering the good practices described in the model;
• differences in the ‘process language’ was perceived to potentially be generating difficulties for the model users to identify, value and apply new knowledge;
• barren context was also perceived to be a potential threat to implementation, due to confrontations between partners; and
• conjectures regarding to the utility of the process model content were identified, i.e. convincing people the model works was a barrier. Therefore, unproven knowledge occurred.

No other measures of implementation stickiness were identified in Company C.

4.4.8 Discussion: hypotheses H5 and H6

The data gathered at Company C does not provide enough evidence to support or refute the research hypothesis 5: H5: Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy.

At Company C factors affecting the transmission, absorption and use of the process model have been identified. However, the process model had not been implemented at the time the case study was developed. Also, the implementation strategy was still to be defined. In this way, it is not known if the factors that have been identified as potentially influencing the model use would be considered and managed as part of the implementation strategy.
Unfortunately, Company C’s data also did not provide enough evidence to support or refute hypothesis 6: **H6**: *Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects that companies in which generic model is not continuously and explicitly updated.*

Due to the fact that the model has never been used in the company, it has also never been replicated through its application in different projects at Company C.

### 4.4.9 Summary of key findings

The main triggers of process model implementation at Company C were to provide support for partnering agreements between four different companies, with a focus on improving process management by defining process activities and reviews. Such reviews focus on enabling planning and proactive process and financial control. The outcomes of implementation could not be assessed in this case study as the process model was still during its design stage when the case study took place. Due to this fact, it was not possible to test most of the research hypothesis with the basis on this case. However, the case provided evidence on process model design activities, on some implementation steps as well as on perceived implementation enablers and restrainers.

The evaluation of the process model content made explicit two shortcomings related to the model credibility in the company, i.e. it was not possible to assess if the model users believed it helps management (therefore there could be acceptability problems), and the role of the process model has not been agreed with the company top management or with the future users of the model. These could represent barriers to the adoption of the model at the project context, as it was actually pointed out in interview 4.

With regards to the implementation process, great emphasis was given to determining the steps for the process model design, but this was done without any regard to its future implementation. This is evidenced by the fact that the company would finish the design of the process model and only then formulate a strategy for its implementation. Furthermore, the process model was to be published in the company intranet and its use mandated throughout the company. As it happened in Company B, it appears that there
was a belief that publishing and mandating the model use would be sufficient for its successful implementation.

Finally, the identified factors potentially affecting implementation were related to soft people issues, i.e. resistance to change, training and clearly demonstrating benefits accruing from the model use.

4.5 Summary and link

This chapter presented the data collected and analysed for the three preliminary case studies developed in this research. Narratives were presented for each case, describing triggers (i.e. why the company decided to invest in process models), the implementation content (i.e. the nature of improvements in the process models developed), the implementation process (i.e. the strategy and steps undertaken to design and implement the model), and the main outcomes in the company (i.e. success or failure). Findings supporting or refuting the research hypothesis were discussed for each of the cases.

A more detailed discussion was presented for Company A, which is the only successful implementation case. It is interesting to note that in both construction cases (companies B and C) there was a strong link between the design and implementation of PDP model and the adoption of new procurement systems, i.e. the alliance for Company B and partnering for Company C. Therefore, the evidence found suggests that in construction the PDP and procurement cannot be separated, as the type of procurement adopted influences the way process activities are developed. This is not the case in manufacturing, as product development is not significantly influenced by procurement.

The next chapter presents the data gathered and analysed for Company D.
5 Research findings: main case study

5.1 Introduction

Chapter four described the data collected and its analysis within the context of the research questions and hypotheses for the three preliminary case studies developed as part of this research.

This chapter presents a detailed description of the main, in depth case study developed. A narrative structure is used to present the main case results, similarly to the one used for the exploratory cases. In the main case study, qualitative data was collected over a period of seven months in which the researcher has taken part as an observer-researcher (see section 3.7.1). The researcher developed five semi-structured interviews, and also took part in a number of meetings in which the design and implementation of the process model were being defined and conducted. Data analysis has been done with the use of content analysis, which support the identification of the fundamental categories of thinking regarding the implementation triggers, the implementation content, process, and the main outcomes in the company, as well as the factors affecting implementation. The framework to evaluate process models with a view to its implementation (see section 4.2.3) has been here used as an analytical model to evaluate Company D’s model content.

5.2 Main case study: Company D

Company D is the main case study of this research. The company is a major civil engineering and construction contractor in the UK. The company has subsidiaries in countries including Australia, USA, Middle East, Malaysia, Egypt, Zimbabwe and Nigeria. The company’s turnover is around £450 million a year, with a staff strength of about 1,200 in the UK.

Company D is divided into different business streams, each of which focuses on the development of different projects: (a) housing developments; (b) office blocks; (c)
healthcare facilities; (d) infrastructure projects, roads and rail; (e) utilities; (f) retail; and (g) industrial units. Usually there are around 60 projects developed each year, with costs in between £2 to £330 million. In average, 70 to 80% of the contracts are procured through Design and Build (D&B), and practically all physical construction is subcontracted. Furthermore, the company has main offices in 18 different regions in the UK. Each regional manager has financial and managerial power over the working practices in each region, and the different regions work fairly independently.

‘Implementing Best Practice (IBP) programme’ is a company wide improvement initiative which was underway by the time this case study was developed, and a design management (DM) process model was part of it. The analysis here presented focuses on the design and implementation of the DM model, and IBP programme aims, objectives and structure are presented to illustrate the context in which the DM model was designed.

### 5.2.1 Implementation triggers

This section presents the drivers for using a process model in Company D by describing the overall IBP programme. The main problems the company faces in managing the design process are discussed, followed by a description of the DM model.

**IBP programme**

Implementing best practice aims at defining and delivering best practice in key areas across Company D. The programme objective is ‘to have a skilled team on every project, working to a common management system using tools to provide a consistent approach to best practice and best profit’. IBP is a three year programme initiated in 2002, in which the company invested in between £2 to £3 million a year in tools, training and IT infrastructure to achieve consistent best practice on all projects.

The decision to invest in IBP resulted from a change in the company business model, in which an increased number of D&B and PFI (Public Finance Initiative) projects were identified. Internal and external evidence of performance gaps was the catalyst for the
improvement need. The realisation of delays in projects delivery and financial losses from unsuccessful projects provided evidence to support the IBP development.

External evidence was gathered from an industry benchmarking with data from the Major Contractors Group Benchmarking Club in 2000, as well as the assessment of the company performance in different areas using the Design and Build Foundation assessment tool in 2000/2001. This information made explicit the need to improve strategic areas of poor performance, i.e. construction time predictability, cost predictability, design management, management of risk and of the supply chain.

As a consequence, six workgroups, each with a board sponsor, were set up to define and deliver ‘best’ practice, i.e. (a) supply chain; (b) design management; (c) package management; (d) risk management; (e) planning; and (f) network services and intranet. Each workgroup focused towards defining improvement strategies as well as developing minimum standards to be achieved for all projects. For each area, new processes, guides and tools were to be developed, focusing on improving skills and also on the IT systems. All the generic processes were to be made available in the company intranet.

Key success factors for the IBP programme were set out as flows: (a) commitment from executive board; (b) agreement to ongoing investment; (c) resources released as required; (d) correct communication strategy; (e) hit the defined targets; (f) strong steering group; (g) removing barriers before they become an issue; and (h) mentoring and support structure.

The workgroup looking into network services and intranet was the first to be set up, followed by one for construction planning. A multi disciplinary team of eight senior managers from throughout the company produced a detailed best practice planning document, which presents a model defining the planning process as well as minimum standards described through guides, templates and pro-formas. The model was published in the company intranet, and training delivered.
Design management was the second workgroup to be set up as part of IBP, and the focus of the analysis here presented. The objective of the design management workgroup was to ‘develop a system to ensure proactive control of all aspects of the design process that delivers compliance and enables construction to be achieved within specific cost, time and quality limits’. The DM process model is presented as follows, after the description of the main design management problems.

Design management problems
In Company D, design management is perceived as a significant risk due to the fact that badly managed design can cause increased construction costs, rework, changes and consequently time delays in project delivery. Design is the most inconsistently managed process across the company, even though its importance is clearly recognised. As stated in interview 6: ‘this is where the problem is, the processes are inconsistent at the moment, and design is the one we are most inconsistent, and that’s the best way of describing it.’ Inappropriate planning, poor design reviews, poor design quality and lack of resources and skills to manage design were some of the issues identified.

Design work is always sublet to external architectural, structural and mechanical and electrical (M&E) consultancies. Design progress is usually monitored against high-level milestones defined by the bid manager. This is not sufficient to properly plan the design process, as the milestones do not focus on the information that should be produced but rather on important activities such as planning approval. Also, design tends to be monitored against the production of drawings instead of information.

Furthermore, there is a belief that the detail design phase should be pulled from construction planning (as both are developed concurrently), but this does not happen due to communication difficulties with external designers, and as a consequence many design decisions are taken on site. Moreover, it has been stated in interview 7 that ‘it is difficult to get adequate drawings on time’ from most designers as a consequence of the poor coordination between the company and designers.
Design review meetings occur less often than it would be appropriate. Design fixity should be sought through these reviews, but the concept of fixity is not well understood, and there is no clarity on how it should be achieved. Furthermore, defining and controlling the design brief is described as a ‘challenge’, as designers have their own agendas which are often conflicting with the company’s interests, e.g. ‘designers want to reduce their own costs... and are not so much [concerned] with reducing construction costs’ (interview 7).

Further difficulties occur when design is novated to the company. This is generally problematic as the design does not consider the company building standards, and the company does not have any financial power to obtain design changes or further details needed (i.e. production information). In addition, sometimes designers are inflexible in terms of not being able to respond to the company requests due to the small size of most design consultancies, which lack slack resources.

The company has in total 12 design managers in the UK, which in general get involved in large D&B construction projects. From those, only three are designers (architects), thus most design managers come from different backgrounds, e.g. planning and programmers or quantity surveyors, which do not have the appropriate skills to manage design. As pointed out in interview 6:

‘we have people doing design management but they don’t actually know how to do it, they are not qualified to do it, ... because they don’t really understand the design process .... So the only thing that they can check it for is if it is buildable, and relatively simple plans, quality plans. So most of them ... tend to operate as information coordinators, its just pushing drawings out of the people, without really analysing quality or the process’.

Moreover, the different regions work independently, and this generates problems in implementing a unified approach, as pointed out in interview 5:

‘They [managers from different regions] are self-contained and they don’t allow anybody in so we can’t see what they do... They have a lot of power, in terms of regions ... in terms of defining in detail how he is going to organise it, and each particular region have their own philosophies’.
Some of the company’s top managers believe that design management should be subcontracted. On the other hand, some managers believe that design is of strategic importance and, therefore, its management should be taken over by the company for its own benefit, as well as for the benefit of its clients especially in D&B and PFI projects.

Finally, the company design managers also suffer difficulties with externally contracted architectural consultancies as in many cases the latter believes the company is taking over their responsibilities. This demonstrate tensions with regards to who should manage design, the designers as service providers, or the contractors, as the internal client.

**Expected benefits of using the DM process model**

Company D decided to design the DM model to achieve different benefits, focusing on eliminating or reducing the problems described above. Benefits were expected for the organisation, the project and client. Organisational wide benefits identified include:

- achieve consistency in all company projects, i.e. all projects being profitable;
- achieve commercial targets and increase the company share on the marketplace;
- apply similar managerial philosophies in design throughout the company;
- create a company wide understanding of design management and of the design process;
- improve design management skills through training, i.e. bring all design managers to a minimum standard and then introduce continuous improvement; and
- avoid duplication of procedures and ‘good practice’ advice.

Different benefits for the project level were also identified:

- achieve a minimum auditable standard throughout design management;
- achieve control of designers and design development (through the DM model);
- eliminate or control project risks to achieve success in all projects;
- enable benchmarking between different projects;
- support the management of design to a minimum auditable standard;
• increase collaboration between company and external designers; and
• have information available to all design managers.

Benefits for the client were explicitly described only in terms of the timely delivery of projects, and no indications of the need for increased product quality were identified in IBP documentation or in the interviews. Nonetheless, it is implicit that better product quality was sought to be achieved via better design management.

The expected benefits identified in Company D are similar to the espoused benefits described in the literature (section 2.2.4). One benefit identified in this case study which was not explicitly addressed in the literature is the possibility of avoiding duplication of good practice advice throughout the company.

In summary, the main triggers for process model design and implementation in Company D was to achieve consistency in all projects through a common understanding of design management, as well as enabling control over design development. In addition, the model should support developing the skills of design managers.

Past improvement initiatives
This section briefly describes previous process improvement initiatives to provide a contextual perspective on the DM model design and implementation in Company D. The DM model was not the first generic process model designed by Company D. The company has had two previous design improvement initiatives. The first initiative culminated in a document called design and build guidance notes: a map of design management activities. This document has been developed by the same person (a senior design manager) who was responsible for the DM model design.

The D&B guidance notes portray a map of design management activities, as well as a number of checklists and guiding notes presented in the form of a manual24. The design management map is described through a flowchart of activities linked to phases defined

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24 The model is represented through eight A4 pages, and the whole document consists of 77 pages.
as the pre-qualification, bid, and construction. Checklists and guidance advice are attached to some of the process activities. When asked about the use of the model in the company, its designer stated (interview 7):

‘I can tell you to what extent it has been taken up, and the answer is not at all, and the reason was there was no proper launch for it, there was no programme to actually implement it, it was put into our intranet system under quality assurance, so it was not a compulsory document, … most of them [design managers and coordinators] couldn’t be bothered because they were too busy.’

Further reasons for the design and build guidance notes not having been adopted in the company were pointed out by the quality assurance manager (interview 6):

‘It was written by … people in the centre [in London], who were not necessarily in touch with how things work out in the real world, it was written very much thinking about the large, £20 to 50 million job, and it was not easy to apply to the £5 million design, and to a particular way to the design novated to us. So it didn’t really reflects true practices, or what actually happens, that’s the problem’

Even though this model was not successfully implemented in the company, and it was not perceived to reflect good practices, it was used as basis for the DM model design, and this has influenced its adoption in the company (see section 5.2.2). The second process modelling initiative in the company involved the development of a model describing the project process to allow the development of a new IT system. A consultancy company was commissioned for the design of this model. It is a ‘to-be’, high-level model describing the whole process through stages, functions and information types, in which company standards are stored. As a result from this work, a decision was made to organise the IBP programme through a ‘cube’, represented in Figure 5.1.
The project process was designed on the basis of a number of interviews and took several months to complete. Nonetheless, a decision was made not to replace the IT systems and as a consequence the project process model was never implemented.

In summary, different process models were devised in the company prior to the DM model, and none of them was successfully implemented. The main reasons for that were identified as the lack of an appropriate implementation strategy, changes in the IT strategies, and conjectures about the ability of the models in improving management. Furthermore, it has been evidenced that information on such initiatives is not easily accessible for company members, e.g. the DM model designer was not aware of the existence of the ‘project process’ model.

**Design management (DM) model description**

The DM model describes the design process from the perspective of the construction company, focusing on the activities to be performed by the design manager. DM is a ‘to-be’ generic model at the firm level (see section 2.2.3), presenting five project phases:

- **get opportunity**: includes finding business opportunities and demonstrating the need for the project;
- **work up to bid**: includes all design stages prior to the beginning of construction. The level of design detail developed will vary accordingly to the contract type;
- **win and start up**: includes the award of the contract, mobilisation and production information;
- **do work**: construction phase as well as detail design/production information;
- **handover and close**: handover of the finished product to the client; and
- **review**: includes project review and operations and maintenance.

Four design management stages are represented under the overall project phases (see Figure 5.2), being described as: (a) preparing to design; (b) managing design; (c) mobilisation, production information and inspection of construction works; and (d)
handover, close and review. Also, the DM model is not subdivided into functions, as it focuses on design management only.

Differently from process maps identified in the literature (see section 2.2.3), which represent the project phases accordingly to the level of design/construction development (e.g. concept, feasibility, detailed design, etc), the DM stages are based on the commercial status of the projects. According to the interviews, this was due to the need for flexibility to adapt to different procurement systems, and there was a belief that more benefits would be accomplished by describing the process in such way. Nonetheless, this generates lack of clarity in the information content of the process in each of its phases, as the relationship between design phases and the project phases are not explicit.
The DM model presents three levels of detail in its description, i.e. the project and design phases, activity and task level as shown in Figure 5.2 and Figure 5.3. The activity and task maps are represented through flowcharts with the inputs, outputs and customers of each activity and are further detailed through tables describing the content of each activity or task presented. Tools and guiding documentation are also presented.

Figure 5.3: Phases, activities and tasks in the DM model

The DM model presents reviews (gates and controls) at both the activity and task levels, spread throughout process phases. Gates are defined as reviews with a conditional decision to proceed, envisaged as director’s level approvals, while control points are developed at the project level, constituting a checking process of the design manager’s responsibility. Such reviews were established as a means of determining the minimum and common set of information that must be available throughout different stages of design development. These are also used to make explicit the links between design management and the process models of other functions in the company.

Gates and controls are further described through pro-formas defining deliverables, information that has to be gathered prior to the gate or control review, as well as an assessment of the design risks. The model has also a continuous improvement aspect to it, as a review is predicted at the project outset, and an annual revision is also predicted.
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The model was developed to be published and used via the company intranet. As a consequence, the high-level model is presented through a ‘navigation page’. On the left hand side of the navigation page there are links with quick access to an introduction and brief explanation of the model, as well as to information on revisions, policy statement and risk management guidelines. On the right hand side the navigation page presents links to lessons learnt (i.e. ‘design management knowledge’) and to tools/guidelines.

Furthermore, the DM model describes a list of key improvements that should be followed in managing all company projects, which were set out as:

- manage design activities to control both the financial and health and safety risks arising in the design process;
- enhance the reputation of the company by managing construction design in a manner that delivers economical, high quality buildings on time, and to deliver good value for money to employers and to the company;
- design risks being formally reviewed at specified stages on every project, appropriate design quality being achieved and non-compliance issues being resolved in a timely fashion;
- all elements of the design being coordinated and interfaces timely resolved;
- design changes being recorded and costed, and the programme and contractual implications being identified before implementation; and
- designers being required to agree a programme for submission of deliverables and the attainment of the deliverables on programme being monitored.

The process model does not provide any information on how it should be implemented. The only consideration on implementation presented is a statement in the introduction to the process model which describes:

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25 The DM model is also available in hard copies, divided in three volumes, describing the generic process model, a set of tools for design management and guidance, comprising a 158 page document.
5.2.2 Implementation outcomes

The implementation of the DM process in Company D was unsuccessful. This has been identified both at the interviews and through the observation of five design management meetings of the project in which the model was to be piloted. The project was an extension of a hospital in London on the PITN phase (Preliminary Invitation to Negotiate), the first step in the PFI bidding process. This project was developed according to the experience of the bid and design managers, without any consideration of the DM model, its activities, gates, control points, procedures or guidance.

Different reasons can be pointed out for the unsuccessful implementation outcomes in Company D, related to myriad issues, i.e. political conflicts at the top management level, the DM model content and the way it was developed, the implementation strategy, and the perceived gains and losses that would accrue from implementation of both the organisational and individual levels.

There were conflicting perspectives between the different regional managers with regards to the organisational gains from implementation. While some managers agreed that the company could accomplish the organisational benefits described in section 4.4.1, others did not agree with it as they understood that more importantly than using a process model would be to appropriately define the design manager skills. On the meeting in which buy-into the model implementation was being sought, discussions focused much more on ‘what is a design manager’ than on the process model itself or on the implementation
strategy. Such divergent perspectives led to a very low level of model buy-in, and to the need for rethinking the implementation strategy (i.e. issues such as training existing employees or engaging new, more skilled design managers became major concerns). This also generated poor support for implementation from top management, which affected the willingness of the design manager to pilot the model.

At the individual level (i.e. the design manager) the perspective that gains at the organisational level would generate loses at the individual level prevailed, as it can be observed as follows. When asked about the benefits of using the model, the design manager pointed out (interview 8):

‘It will be achieving a common understanding of the design process, which is the good side. The bad side is perhaps, it is a way of monitoring other people, what they should and what they should not be doing …that means giving the privilege to the firm that we should be looking at design in their way … [do you think that’s why the model is not being implemented?] Yes. You should agree that it would cause a cultural concern, a negative concern on implementing the process.’

It is clear that the design manager believed the model would be used to control his work as opposed to control the process and the design quality. In this way, it was perceived that the ability to control the design manager’s work was a benefit for the organisational level but a loss at the individual level. Therefore, the process model content and the lack of involvement of design managers in its development also undermined implementation success. Issues relating to the poor model applicability and usefulness played an important role on implementation, as discussed in section 4.2.3. Furthermore, the lack of a clearly structured implementation strategy also negatively influenced implementation, as described in section 5.2.5.

Therefore, it is possible to state that there were tensions in the individual perspectives of the strategic management objectives about the DM model implementation. The hierarchical breakdown of strategic management objectives at the design management level was not possible, and without clear objectives implementation was not successful.
5.2.3 DM model content evaluation

The analysis of the DM model content is presented in two sections. Initially the analysis of the model performed by the researcher during the process model design is presented, and changes introduced in the model as a result of the analysis discussed. Following, the model content evaluation with a view to its implementation is presented.

Analysis of the DM model during the model design

The researcher analysed the DM model during its design, and as a result Company D introduced changes in the model content and presentation structure. The analysis aimed to enable the model refinement and improvement. It also aimed at providing the researcher with an understanding of the model content, which would allow the identification of the effects it had over the success of its adoption. The analysis consisted in identifying the extent to which the model considered key principles that provide a basis for an improved process, as proposed in the process protocol.

Recommendations on the key process principles were discussed in two meetings with the IBP programme manager, DM model designer and with the design manager responsible for pilot implementation. Discussions were based around the concepts described on the left hand side of Table 5.1. The table also describes the changes introduced in the model as a result of the analysis. In summary, the main points evidenced were:

- flexibility and customisation were not considered, which demonstrates that the model use was not sufficiently considered during its design.
- the DM model was not appropriately linked to the whole lifecycle of the project, and its alignment with the company’s business process, project process and design management was inappropriate;
- gates and controls were defined only during design, being approached as points where a checklist was completed; no approvals to proceed, planning or deliverables were considered, undermining the concept of phase reviews;
### Table 5.1: Analysis of key process principles and changes introduced in the DM model by the company

<table>
<thead>
<tr>
<th>Key process principles and recommendations</th>
<th>Changes introduced in the model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whole project view</strong></td>
<td></td>
</tr>
<tr>
<td>Not considered in the model, as it focuses solely on design management. The links between the business, project process and design management were not clear. The model does not cover the whole lifecycle of a project as no post-handover activities are presented.</td>
<td>• Model was linked to a high-level matrix describing the main project stages, the different functions and all gates throughout the process</td>
</tr>
<tr>
<td><strong>A consistent process</strong></td>
<td></td>
</tr>
<tr>
<td>Gates were defined during design only, not throughout the whole project process. This demonstrated lack of integration and consistency between design and the whole project process. There were no performance measures in the model.</td>
<td>• Phase reviews were defined for different stages of the whole project, in the bid management model  • Performance measures were not included – they were to be part of future model development</td>
</tr>
<tr>
<td><strong>Progressive design fixity</strong></td>
<td></td>
</tr>
<tr>
<td>Gates were predicted but were conceptualised as checklists of activities only. The gates did not provide for consistent planning and review procedures. Design fixity needed to be defined, as well as project deliverables.</td>
<td>• Gates were explored to include deliverables, programmes showing progress, and a meeting through which authority to proceed is granted  • Gates were approached as means for implementation, as most activities prescribed in the model would have been done to allow design reviews. Nonetheless reviews do not provide for consistent planning as they are not attached to design phases,  • Design fixity was included through design freeze meetings, but the concept of those was not detailed.</td>
</tr>
<tr>
<td><strong>Co-ordination</strong></td>
<td></td>
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<tr>
<td>The design manager should have authority to co-ordinate the participants and activities of each phase, ensuring the adaptation and correct application of the model to the project in hand.</td>
<td>• Role and skills of the design manager were defined as part of the model design, with the appropriate emphasis on the coordination of all stakeholders involved in design as well as on implementing the model</td>
</tr>
<tr>
<td><strong>Stakeholder involvement/teamwork:</strong></td>
<td></td>
</tr>
<tr>
<td>Right people should have the right information at the right time throughout the process. Nonetheless, the correct identification and prioritisation of the stakeholders and their needs was not considered. Strategies to achieve teamwork throughout the process were not considered. The definition of information needs was not done.</td>
<td>• The design team organisation and skills were not defined, therefore no action taken with that respect  • Stakeholders needs in terms of information at a generic level were included in the model</td>
</tr>
<tr>
<td><strong>Feedback:</strong></td>
<td></td>
</tr>
<tr>
<td>A final project review was defined in the model. Nonetheless, it included only a designers’ performance review. No evaluation of the design development was part of the review. The way that specific project information would be stored, published and would effectively feedback the process model was not determined.</td>
<td>• No changes were introduced in the model with regards to feedback, even though the team considered it necessary</td>
</tr>
<tr>
<td><strong>Process flexibility</strong></td>
<td></td>
</tr>
<tr>
<td>There were no considerations with regards to process flexibility in the model. The process was not being appropriately agreed with project stakeholders. The team needed to define which activities would be mandatory and which would be flexible.</td>
<td>• Process flexibility was considered in terms of making explicit the need adapt the process to the size of the project. No considerations on the application of the model to different business areas were made (e.g. civil engineering and building)  • It was explicitly defined in the model that the high level activities, gates and controls would be mandatory</td>
</tr>
<tr>
<td><strong>Customisable process</strong></td>
<td></td>
</tr>
<tr>
<td>The flexibility of the model should ensure that customised specific models are created. No considerations on customisation were made in the DM model. How specific models would be established and communicated needed to be determined. Also, the importance of agreeing the model characteristics with project stakeholders was not approached.</td>
<td>• No changes were introduced in the model with respect to determining its customisation.  • The process model designer considered that only design managers should be involved in the process model development.</td>
</tr>
</tbody>
</table>
• team organisation and strategies for teamwork were not considered in the model;
• most design development activities were not included in the model;
• design related activities which are performed by stakeholders other than the design manager or designers were not defined as part of the model, which could potentially bring fragmentation to the process; and
• design fixity and performance measures were not included.

Most issues raised by the researcher were considered relevant by the company members for improving the model content. Nonetheless, some were disregarded. Interestingly, no action was taken into the issues related to the model use. Finally, the company members made explicit that there was a trade-off between the need of accuracy and simplicity of the process model. It was stated that the more accurate, the more complex the final model would be. This demonstrates a perception that greater accuracy could be achieved only to the expense of the model simplicity.

**DM model content evaluation using the framework**
This section describes the analysis of the final DM model content with a view to its implementation. The model has been evaluated both in terms of the applicability and usefulness at the company level. Table 5.2 presents interview transcripts as sources of data along with the researcher’s assessment of the model.
Table 5.2: Model evaluation with a view to its implementation in Company D

<table>
<thead>
<tr>
<th>Headline criteria</th>
<th>Attributes</th>
<th>Sources of data</th>
</tr>
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<tbody>
<tr>
<td>Flexible?</td>
<td>Generalisable to different areas</td>
<td>‘inverted commas &amp; italics’: extracts from interview transcript</td>
</tr>
</tbody>
</table>
|                   |            | The model is generic, and should be used for all Company D projects, both for building and civil engineering works: 
  'We are going to have that generic top level one that is flexible enough and then we are going to draw it down into local, specific ones depending on the form of contract.' |
|                   |            | Nonetheless, it is difficult to adapt it to different projects sizes and also to apply it to civil engineering works: 
  'The main problem is getting agreement, different people have got preconceived ideas of how things are done, or should be done, in different parts of the business, because .... quite often civil engineering do things differently from the building people, so trying to "guess" a common agreement just on how things are going to be done is quite difficult and trying to persuade people, ... just because we think that is the best way, is not necessarily the best way...there is a far amount of problems with that’ |
|                   |            | Finally, it was evident that generalisability was not appropriately considered during the model design. When the process model designer was asked about how the model was to be applied to different sizes and types of contracts, the answer was: 
  'That is a thing that we haven’t touched yet, I mean that’s the ideal model of course and it’s written for all projects .... [Company D] isn’t supposed to be doing anything under 2 million pounds, but in fact most of the projects are sort in between 5 million I suppose.... the answer is I don’t know yet, but it is really a problem to be addressed.’ |
|                   | Updated regularly | The model is supposed to be updated accordingly to information collected at the outset of projects, nonetheless difficulties were pointed out: 
  'Basically what we said is that in the beginning we are going to put the standard project process into the navigator and then we are going to link it with projects. But it is difficult because when you start to built the process for that particular project, you can see improvements in the way company do things, and that’s something we actually causing us to think about how to update it... someone has got to update that from the project, and it is difficult to do that’. |
| Easy to use?      | Presentation and structure (simple and clear) | The DM model is presented simply, having 3 clearly defined levels of detail making the access to information simple. It has been published in the company intranet, and there information is accessible by setting activities as ‘hot buttons’. The flowchart structure is clear and easily understood. 
  'I suppose that the process model has to be as user friendly and as understandable as possible, and certainly the navigation page in the navigator [company intranet], and everyone that saw it in the company, in two or three minutes they say, yes, I understand it, so that’s nice and easy, its very quick, even with people that haven’t seen it before. So I think people get excited about it because it is very simple .... quite how attractive it will be is other thing; it provides quick and easy access to information at the moment’.
The model lacks clarity in terms of the links between the whole process stages and the design management main phases, as well as links between design management and bid management. Roles and responsibilities of stakeholders are not clearly defined. How the gates are to be applied was unclear:

‘If you look into the process there is a number of gates which say you then go to the bid, and historically in a number of projects there is a manager who looks after the bid, but then how?’

Finally, the design manager believed that others could not understand the model content due to lack of knowledge about design:

‘I’m not too sure if everybody could understand it really properly, which to be fair, they’ve got to understand the design process, they need training, building trust’.

The model provided for consideration of different scenarios and discussion of problems and potential solutions at the company level, but not at the project level. Design management problems were evidenced throughout the model design, and a forum allowing their discussion throughout the company was made possible in the meetings where the model buy-in was sought. Nonetheless, at the project level, the model did not provide for discussions.
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### Credible?

**Model role agreed**

The role of the process model in the company is to be the basis for control, bringing all projects to a minimum standard and avoiding major risk:

‘It’s just inconsistency across the company, and what we are willing to do is to bring everyone to a minimum standard, not necessarily the best standard, ... it is a minimum standard and say that if everybody meets that minimum standard it will be ok, we will be turning in 6% profit. And then practice will be to increase that standard, and get better’.

Nonetheless, there were conflicting views about the role that the company should have in managing design, and as a consequence the role of the model throughout the company was not agreed. This was evidenced only when the model design was already finished and was about to be pilot implemented. Conflicts regarding the perceived role of the model at the individual level (e.g. design manager believed the model would be used to control his own work) also demonstrates the lack of a shared vision of the role of the model throughout the company:

‘Ideally everybody should know what they are doing, ...there is nothing in there that people shouldn’t already be doing, so in theory it’s just a reference document, for someone that isn’t used to the company. Other than that, there is the guidance, so that’s what you must do, this is telling you how to do things, and additional information, things like outputs, tools ... it’s just a successful way of doing things ... So ideally it’s a reference, but we mean it as a bible.’

‘The project manager has a lot of powers, in terms of regions, in terms of defining in detail how he is going to organise it, and each particular region has their own philosophies... this makes the implementation of a process map not easy, so something has to be changed’

### Valid?

**Applied in pilot implement.**

The process was not successfully pilot implemented, as stated in section 5.2.2:

‘Some people can see the benefit of implementing the model while others can’t’

‘The idea is to demonstrate what we do, the way we work. I don’t think I can tell people what to do...’

** Appropriately describes process**

The model appropriately describes the ‘to-be’ process, and it is possible to clearly identify improvements to current company practices, as for instance the introduction of gates and controls throughout the process.

### Measurable?

**Performance indicators**

Performance indicators were not included in the model:

‘We use performance indicators, but at the moment not to evaluate design. We have several indicators for the market, and from the working groups and they recognise that monitoring design, actually monitoring buildability of design has to start, but actually nobody has done any work on that. We monitor the progress of design, but little more than that’
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The DM model applicability has been evaluated considering flexibility, ease of use and credibility. The DM model has been developed aiming to be flexible to different business units, sizes and types of projects. Nonetheless, difficulties both in terms of its adaptation to different business areas and project sizes were identified. The model was devised focusing on major sized building design projects, therefore it is difficult to be adapted to civil engineering projects and to small sized building projects. Flexibility in terms of the process activities, roles and deliverables was not considered, and as a result the model is presented rather as a prescriptive definition of ‘what should be done’. On the other hand, the model was flexible in the sense that it should be constantly updated to reflect project and business changes.

In terms of ease of use, the DM model presents a clear and simple structure with a set of principles and provides simple information accessibility. Nonetheless, the model lacks proper knowledge codification, as links between design and bid management are not clear, and roles and responsibility not sufficiently addressed. Major difficulties with regards to the definition of the links between design management and bid management (i.e. between the business process and the initial stages of the project process) happened throughout the process model design, and generated major rework throughout the model design. This is evidenced by the interview 7:

‘This is not the bid process, this is the management of design and when I started working on this one it got enormously complicated because I was tracking bid for all the different types of contracts to it and it was turning into a bid process management map, of which design was a feature’.

The model content was also perceived not to be easily understood by a stakeholder that does not have previous knowledge about the design process. Therefore, the lack of clarity in the knowledge codification makes the model difficult to be used.

The DM model was also not credible within the company. Conflicting views with regard to the role of the model in the company by top managers coupled with the design manager beliefs that the model does not represent good practices and that it would be used to control people as opposed to the process were issues that destabilised user acceptability. Even though the model provided for fruitful discussions at the top management level (different regional managers) with regard to the role of design and of design management, it has not provided for such considerations at the project level and therefore, the model was not useful to improve design management.
This lack of clarity on the company strategy with regards to design management culminated in the model not being piloted, and as a consequence not validated. Finally, the model did not present any performance indicators, and therefore it would be difficult to measure improvements achieved through its use in real projects.

5.2.4 Discussion: research hypotheses H1 and H2

The Company D data provide evidence to support research hypothesis 1: **H1**: *Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful.*

The DM model evaluation demonstrated limitations in terms of applicability and usefulness both at the organisational and individual levels. In this case study, the model was considered not to be sufficiently flexible, it was difficult to use by people without enough knowledge about the design process, and it has not been validated. As a consequence, at Company D, the implementation of the process model was ineffective.

Furthermore, too much emphasis was given to the role of the model as a ‘control tool’, which led to a misinterpretation of the role of the model as being a tool to control people (design managers) as opposed to a tool to improve the design process. This was a major barrier, as it stopped pilot implementation and generated a company cultural concern with regard to the top management’s objectives in mandating the process model use throughout the company.

Company D’s case did not provide enough information to support or refute the research hypothesis 2: **H2**: *Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use.*

The DM model does not include performance measures either for design or for the process model use, therefore research hypothesis 2 could not be assessed. Even though,
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it is possible to state that there is a perceived importance on the use of performance measurement as part of the process model implementation.

5.2.5 Implementation process

This section describes the implementation process in Company D, focusing on the preliminary activities of the IBP programme for the design management workgroup. The section also illustrates how knowledge has been gathered and transferred from the process model developer to its users, and the consequences this had in terms of its use in the company.

The implementation process has been subdivided into two stages, pre-implementation and implementation, as presented in Figure 5.4. As described earlier, implementation started with the identification of the need to improve a number of processes within Company D, which were evaluated at a high, strategic level. As a result, the need for the IBP improvement initiative was established, and buy-in was achieved from the company board of directors.

![Figure 5.4: Steps of the implementation process for Company D](image-url)
After the six main improvement areas were selected, teams were established to develop the activities of each workgroup. The design management workgroup team was composed by the programme manager for the overall IBP initiative, a senior design manager who designed the DM model, and two design managers who were consulted throughout the model design.

This team detailed the targets and scope of the design management workgroup. A vision for design management was established, which focused on achieving a minimum auditable standard to be attained in all company projects. The main targets of the workgroup included the development of a centre of design excellence within the company, the design of the DM process model, training to improve the capabilities of design managers and coordinators, as well as the implementation of a design collaboration system, i.e. a project extranet. In such way, the expected project deliverables were defined as well as the needs in terms of processes, technology and people, focusing on skills development.

Information on design guidance and previously developed process models was then collected and briefly analysed by the team. The DM model was designed with basis on the information described in the D&B guiding notes (which were developed by the same senior manager who designed the DM model), although these were not implemented in the company. A further source of information used to build the DM model was the RIBA plan of work (RIBA, 1980).

A project plan for the DM model design and training was then devised by the IBP programme manager. The design management programme was expected to have a duration of 8 months but, effectively, only the model design took longer than 10 months to complete, which demonstrates the company a priori belief that the task of designing the process model would be simpler than it effectively was.

The model design was done through a number of cycles which included the production of a draft process map, discussions through e-mails and workgroup meetings, and the redraft of the model until consensus was reached. Receiving feedback on the model was considered vital by its designer, as it would become a mandatory procedure. A management committee composed of the company regional directors was also involved in providing feedback on the model, but this was done mostly through e-mails. The
feedback also included the analysis provided by the researcher, as represented in Figure 5.5. Most guidance and tools were inherited from the D&B guidance notes, but new tools were also developed.

![Diagram of DM model design activities]

**Figure 5.5: DM model design activities**

The initial model draft described the bid process alongside design management, and as a consequence the map presented different activities which needed to be developed accordingly to the different bid types. Nonetheless, a decision was made to take out of the design process management map all bid-related activities as the model designer did not feel sufficiently skilled to develop a map for all the different bidding processes, and a separate bid map was produced by the IBP programme manager. Both maps linked through the gates and control reviews.

After a well defined version of the DM model was finalised, the IBP programme manager decided that the DM model should be developed accordingly to the same presentation structure that has been used in the planning process model. This decision was made to allow the model to be published in the company intranet. Nonetheless, it created a major delay in the process model design, as the new structure impinged a different organisation of the process model and its activities. Also, a consultancy company was involved in redrafting the model accordingly to the new presentation standards.

The process model implementation strategy was considered only at the stage in which the DM model design was finalised. As a consequence, the model itself does not include any considerations of how it should be adapted and used throughout the company. At that stage, the implementation strategy focused solely on publicising the model in the
company intranet, and on the selection of a project in which the process model was to be piloted. No formal training was provided for the design manager responsible for this particular project, and the benefits of implementation at the project level were not clearly demonstrated. The team considered that it would not be necessary to provide training or define pilot implementation activities, as the design manager was part of the workgroup team. However, pilot implementation was unsuccessful.

Even though the model was not validated, the team decided to disseminate its use throughout the company. Buy-in from regional managers was sought through a workshop in which the model was presented and its implementation discussed. The workshop included considerations on the following issues:

- the purpose and overview of the DM model;
- commitment to implementation: the discussion on unsuccessful past implementation experiences; need for support to implement from the company board of directors, identified PFI and D&B contracts as key commercial targets for the company, and presented the importance of managing risks throughout design;
- issues on procuring appropriately skilled design consultants;
- the capabilities of the design manager were presented as 7 key skills: design procurement, commercial interface, project standards, design coordination, design verification, programme and performance measurement, and project systems (IT focused); and
- the overview of a training strategy aiming to introduce the standards set out in the process model was also presented. Training would include regional directors, estimating directors, design managers, bid managers, quantity surveyors and project managers responsible for D&B contracts.

As stated previously, major debates about the company position in managing design, the role of design managers, and the structure of the training programme occurred at this workshop. This made explicit the conflicting viewpoints of the regional managers with regards to how design should be managed, as well as on the potential benefits from the model use. Another outcome of the workshop was that it became apparent that there would be great difficulties in achieving buy-in and effectively implementing the process model due to such conflicting perspectives.
Further problems were identified throughout the DM model design and tentative implementation process, being described as follows. The approach used to design the process model was unstructured, as there was no structured planning for it. The feedback on the process model drafts was being received in a scattered manner, which generated a number of redesigns of the model, and no criteria to analyse the model content or to attain to decisions previously made were used. Most of the feedback on the process model was given to the model designer by the IBP programme manager, which was not knowledgeable on the design process. Also, a major or strategic change in terms of the presentation structure of the process model occurred when the model was almost finalised, and as a consequence the model needed to be completely redrafted. All these issues generated major delays during the process model design.

Little consideration was given to the information used as a source for designing the DM model. The fact that the model was being drawn on the basis of an untested previously set model (considered unsuccessful by future model users) and on the RIBA plan of work (considered outdated by model users) caused the design manager (model user) to believe that the model does not represent good practices, and therefore he was unfavourable to its use.

Furthermore, the person responsible for the process model design was not aware of the existence of the ‘project process’ model previously devised by a consultancy company. This factor demonstrates that not all the existing information in the company was considered as input for the model design. Furthermore, the existing, or ‘as-is’ process was neither defined nor analysed, therefore process changes were proposed without the appropriate consideration of the real state of the process. Design management problems were well known, but the causes of problems were not appropriately analysed, and no performance gaps determined. These issues made it unfeasible for the company to verify if the principles of change being proposed in the model were adequate.

The model designer has not been involved with the formulation of the process model design strategy, as is made explicit in this extract from interview 7: ‘I don’t understand everything that’s on it, sorry about that. I didn’t do the programmes, so that’s why’. This demonstrates that there wasn’t an effective agreement in terms of the model design
steps. Rather, that was delegated by the programme manager, and as a consequence the model designer was not sufficiently committed to the model implementation.

The model designer also had difficulties with regards to the definition of the level of generality of the model, and the level of control that the model needed to present over the design manager activities, as it can be observed as follows (interview 7):

‘If you make it too generic then people could do whatever and then we would miss the goal of it, so anybody could do it accordingly to his own perceptions … I can see the problem of that [building flexibility in the model] would be that you will be giving people an excuse to bane it, to sort of jump activities, because they haven’t done what they should really’

A further problem was that nobody from the civil engineering side of the company was involved in the process model design. The reason for that and potential negative influence over implementation are clear in the following extract of interview 8:

‘I think design tends to be much more complicated in the building side than in the civil engineering side, and that is always the case, but the risk here is that we will be sitting at a building manual, on the way of doing things, and the civil engineering people wont refer to it, and they wont be integrated’.

Furthermore, the model solely considered the management of architectural design, and did not adequately incorporate other design issues, as evidenced by this e-mail extract:

‘Whilst final editing is taking place, efforts will be made to broaden the references to acknowledge M&E and structural engineering matters and also its application to different sizes of contract. At the same time an attempt will be made to extract some of the steps into guidance notes, if possible, in order to reduce the number of mandatory steps.’

In summary, it can be stated that there was not enough involvement of the future process model users during the process model. As a consequence, user requirements were not appropriately considered, and users could not realise individual benefits from implementation. As stated in interview 8, users were not involved in the model design as a means to simplify the process, but this had adverse influences over implementation as model buy-in was not achieved. Finally, the design manager stated that the researcher were more knowledgeable about the DM model content than himself. This demonstrates that strategic directions and training should have been made available prior to attempting pilot implementation.
5.2.6 Discussion: research hypotheses H3 and H4

The data presented in section 5.2.5 provides indicative support for the research hypothesis 3: **H3**: Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation and adoption does not occur.

In Company D, at the pilot implementation, the DM model was not adapted into a project specific model and consequently not adopted in the project context to guide actions of the project team. Even though the design manager acknowledged that the only way to successfully implement the model would be through the creation of a project specific model, this was not done as a result of the lack of interest of the design manager on implementation. As the model was not adapted, implementation was unsuccessful. The need for adapting the model to suit specific business units and project needs was clearly acknowledged by all parties involved. Therefore, it is possible to state that model adaptation is perceived as essential for successful implementation.

The theoretical framework presented in Figure 2.8 partially reflects Company D’s steps on their process model design and implementation. The company defined the strategy for the process model design and designed the model, but without appropriately considering the need for adaptation at both the business units and the project level. Furthermore, the implementation strategy was considered only after the process model design was finalised. This fact, coupled with political problems in terms of conflicting views about design management, led to the unsuccessful pilot implementation.

Furthermore, it is possible to state that the process model design was not effective in unfreezing the current process state, as future model users and regional managers were not appropriately involved with it. Also, even the design manager which was involved with the model design did not ‘unfreeze’ the current process state as he did not believed the model would bring individual or organisational wide benefits.

This provides support for the research hypothesis 4: **H4**: Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP implementation and replication
when compared to companies where future users do not participate in the model development.

In Company D the process model was not designed in full collaboration with its future users (only 2 design managers were involved, while 12 design managers/coordinators were expected to use the model). Even in the pilot implementation, where the future model user was collaborating and involved in the model design, lack of motivation lead to implementation failure. The belief that the model would be used for control rather than for process improvement severely hampered the design manager’s motivation to implement. Lack of motivation also happened due to the conflicting views between top managers on the importance of the DM model as a means to improve design management. Therefore, Company D findings demonstrate the great influence that motivation has over successful implementation.

The fact that future model users were not appropriately involved in the model design might also lead to future implementation difficulties. Certainly, lack of involvement of the company regional managers in the strategic definitions of the model objectives and role hindered the model buy-in and, consequently, its implementation throughout the different company regions. Therefore, low levels of collaboration between model developers and users and low levels of motivation to use the model directed to unsuccessful implementation outcomes in Company D.

5.2.7 Implementation content: factors affecting implementation

Factors affecting implementation in Company D are described in this section. Drivers, enablers and restraining forces are presented according to their effects over implementation triggers, content, process and outcomes. Nonetheless, the factors have also been classified according to a typology which emerged from content analysis, i.e.:

- **communications**: factors related to the ease of communications between model designers and users;
- **implementation strategy**: factors related to the clarity, simplicity and effectiveness of the defined implementation strategy;
- **information technology**: factors related to the use of IT to support and publish the process model;
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- **people**: soft issues including skills, motivation and resistance to change;
- **organisational and project context**: issues of the organisational structure and specific project context;

Table 5.3 presents the drivers and enabling forces affecting implementation as identified in Company D for each of the five categories identified. Table 5.4 presents the restraining forces acting upon implementation in Company D.

**Table 5.3: Drivers and enablers affecting implementation triggers, content, process and outcomes in Company D**

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Triggers</th>
<th>Content</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>• no evidence</td>
<td>• consider user requirements in model design</td>
<td>• internal marketing and publication</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• user friendly and simple format</td>
<td>• face to face interaction: model designer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and users</td>
<td></td>
</tr>
<tr>
<td>Implementation strategy</td>
<td>• support from top</td>
<td>• having gates and controls</td>
<td>• no evidence</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td>management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• objectives clearly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>defined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>• no evidence</td>
<td>• no evidence</td>
<td>• information accessibility and availability</td>
<td>• no evidence</td>
</tr>
<tr>
<td>People</td>
<td>• buy-in from</td>
<td>• no evidence</td>
<td>• involve right people with</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td>regional management</td>
<td></td>
<td>implementation</td>
<td></td>
</tr>
<tr>
<td>Organisation &amp; project context</td>
<td>• Top management</td>
<td>• no evidence</td>
<td>• no evidence</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td>understands design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>impacts</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Enablers**

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Triggers</th>
<th>Content</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>• no evidence</td>
<td>• similar presentation structure for all</td>
<td>• present model when it has enough</td>
<td>• common understanding by</td>
</tr>
<tr>
<td></td>
<td></td>
<td>company models</td>
<td>information to attract interest</td>
<td>all</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• pull processes together</td>
<td>• feedback in model design</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• review existing docs</td>
<td>• feedback on specific project</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• training</td>
<td>experiences</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• mandatory model</td>
<td>• monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• easy to visualise through IT</td>
<td>effectiveness</td>
</tr>
<tr>
<td>IT</td>
<td>• no evidence</td>
<td>• self explanatory model due to IT</td>
<td>• networking secure areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• easy to visualise through IT</td>
<td>• create routine on using the model by</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>inputting project info on the system</td>
<td></td>
</tr>
<tr>
<td>People</td>
<td>• commit managers and</td>
<td>• no evidence</td>
<td>• project processes (all specific project</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td>users</td>
<td></td>
<td>information) in the IT system</td>
<td></td>
</tr>
<tr>
<td>Organisation &amp; project context</td>
<td>• need to improve design</td>
<td>• high variability between project results</td>
<td>• well structured project teams</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(great financial losses)</td>
<td>• organisational slack</td>
<td></td>
</tr>
</tbody>
</table>

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Table 5.4: Restraining forces affecting implementation triggers, content, process and outcomes in Company D

<table>
<thead>
<tr>
<th>Restraining</th>
<th>Triggers</th>
<th>Content</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>• design managers difficulties to communicate with top management • not clearly communicate model outputs • differences in the language used throughout the company • poor definition of the design process boundaries</td>
<td>• excessive level of detail • not clearly communicate model outputs • differences in the language used throughout the company • poor definition of the design process boundaries</td>
<td>• lack of clarity on key principles • duplication of documents • segregation between business units • poor communications: model developer and users and within workgroups</td>
<td>• lack of continuity within project teams</td>
</tr>
<tr>
<td>Implementation strategy</td>
<td>• ineffective strategic directions • benefits not clearly demonstrated • skills and resources needed not appropriately defined</td>
<td>• information used to design the model not credible • considers only one business unit (building) • do not consider regional differences • excessive knowledge complexity to some • information elementary to some</td>
<td>• poor involvement model users • pilot failure • do not consider how to adapt model • excessive time in model design • impl. feasibility not considered • model usefulness at individual level not considered • impl. not planned locally and not agreed</td>
<td>• not assessing implications of implementation • lack of performance measures</td>
</tr>
<tr>
<td>IT</td>
<td>• no evidence</td>
<td>• difficult to update the model once published in the intranet system</td>
<td>• cost and time to develop the system • IT adverse people • variations on the use of IT in projects</td>
<td>• no evidence</td>
</tr>
<tr>
<td>People</td>
<td>• lack of buy-in from regional management • different preconceived ideas on design management throughout the company (subcultures) • lack of agreement of model aims by top managers</td>
<td>• poor understanding of the model • lack of capability to manage design • lack of skills to implement • model perceived as a way to monitor people • model perceived as difficult to adapt to different contexts: not applicable to business units • excessive focus on control • prescriptive model • lack commitment and buy-in</td>
<td>• impl. rewards • users could not see benefits to implement or to compare performance between projects • model designer not perceived as reliable • information used to design model not perceived as reliable • differences between personal and corporate interests • lack training • lack motivation model user • lack motivation model developer</td>
<td>• lack of willingness to adapt the model</td>
</tr>
<tr>
<td>Organisation &amp; project context</td>
<td>• design management seen as a risk</td>
<td>• lack of a clear design strategy • variability of the design process • lack of agreement on design management role</td>
<td>• inconsistent managerial philosophies • self contained regions • excess power of the project manager • lack of team continuity between bid and construction • tight deadlines on projects</td>
<td>• no evidence</td>
</tr>
</tbody>
</table>

Force field analysis has been used to graphically present the main driving and restraining forces identified for each of the main categories, presenting an inferred score for each intervening variable identified throughout the data analysis (see section 3.7.2). Driving forces are represented in the top of the graphs in dark blue (positive values),
and restraining forces are represented in the bottom of the graphs in yellow (negative values).

Figure 5.6: Force field analysis: factors affecting implementation related to communications

Figure 5.6 presents the driving/enabling and restraining forces related to communications effectiveness. Implementation drivers identified relate to using internal marketing to disseminate and achieve model buy-in throughout the company. Also, clearly demonstrating that user requirements were considered as part of the process model design was beneficial for implementation. Nonetheless, it is interesting to note that the barrier posed by not appropriately considering user requirements is potentially stronger than the benefit that considering requirements has on the implementation process, as perceived by the process model designer.

Further drivers identified relate to presenting the model in a common, user friendly and simple format and having face to face interactions between the process model designer and users to support tacit knowledge transfer and absorption of the model content. However, insufficient face to face contact between model designer and users was also
posed as a major barrier. The model designer also pointed out that presenting the model to future users only when it has sufficient information is important, as sometimes people lose interest if they perceive the model to be too simple or elementary.

Difficulties in communications between the design manager and the company top management were also identified as implementation barriers. The design manager responsible for pilot implementation pointed out that he would only use the model if he was certain that top management would effectively use the information to analyse the project results. Nonetheless, as the communication between design managers and the company top management was difficult, the design manager assumed that the model implementation was not strategically important for top management, and this hindered the model use. This happened even though top management was supportive of the model implementation, as a result of inadequate communications.

Communication barriers related to the model content also negatively affected implementation. Those include the excessive level of detail of the model and the ineffective communication of the expected outputs of the model use. It has been identified that the level of detail presented in the model was problematic as too much time would be needed to understand and adapt the model to the project context. Nonetheless, it is important to state that this is only a perceived barrier, as the model has not been adapted to a project context.

The ineffective communication of the expected outputs of the model use generated conjectures about the model, as the design manager believed it would be used to monitor his work, as previously described. An additional perceived barrier to implementation was the fact that throughout the company different language is used to refer to the similar process activities, and a concern of the model designer was that those differences could generate a misunderstandings and consequently disbelief in the model effectiveness.
Figure 5.7 presents the driving/enabling and restraining forces related to the implementation strategy effectiveness in Company D. Having gates and controls defined, involving and motivating users, and considering how to adapt the model were the main drivers identified. Support from top management and having the implementation objectives clearly defined and were further important drivers.

The gates and controls were considered the most important and beneficial part of the DM model, and there was a belief that the gates could effectively provide for process control. The importance and need of clearly defining implementation objectives was widely acknowledged through all the interviews, nonetheless the lack of clarity in such objectives was one of the major causes for the lack of success in the DM pilot implementation.

Further enablers were identified as reviewing existent process documentation to support the DM model design, provide training, the model use being mandatory, implementation implications being defined and finally using specific project information to feedback the
model. However, the company had issues regarding all these enablers. Not all existent process documentation was used during the model design (the model designer was not aware of the existence of the ‘project process’), training was not provided prior to pilot implementation, implications of implementation were not considered, and even though pilot implementation was mandated in project, the model was not effectively used in that specific context.

A number of restraining forces were identified in the implementation strategy. Strategic directions were not effectively defined, and the benefits of implementation at the individual level were not defined or clearly demonstrated. The skills and resources needed both in terms of design management and in terms of supporting implementation were not taken into account in the strategy, and as a result the role of the company in managing design and the role of the model within the company were discussed only after the model was developed.

Furthermore, the model user considered that the information used to design the model was not credible, as the D&B guidance notes were not validated and the RIBA plan of work was outdated. Also, the facts that the model was designed without considering regional differences and focused only to the building side of the company are possible major barriers to the model use.

The poor involvement of the model designer in the definition of the programme for the model design, and lack of consideration of the model usefulness and adaptation at the project level directly influenced the failure of the pilot implementation. Furthermore, the lack of an agreed implementation programme led to extensive process model redesign and to delays in finalising the model. Finally, it was believed in the company that if the model was effectively used, it would be difficult to assess the implications of implementation due to the lack of performance measures, and that this could potentially obstruct implementation at the long term.
Figure 5.8: Force field analysis: factors affecting implementation related to the use of Information Technology (IT)

Figure 5.8 presents the driving/enabling and restraining forces related to the information technology (IT) use to support implementation in Company D. IT was perceived to enable implementation as it makes information easy available to all and it simplifies the visualisation of the model as a whole as well as its parts. Also, the presentation structure of the model, determined by its use in the intranet, has induced the model designers to produce it in such a way that it became as self-explanatory as possible.

The model being published in a widely accessible networking area was also beneficial, as all stakeholders can access information at any time and from any location. Furthermore, the company aimed to have in the future a central database available through the web with specific project information linked to the DM model. Such structure was perceived by both the IBP programme manager and the quality assurance manager as key enablers of the process model use, as it would enable the creation of a routine in terms of structuring the specific project processes around the DM model.

Nonetheless, IT has also been perceived to negatively influence the model use in different ways. One problem identified by the IBP manager, the responsible for IT
development and the quality assurance manager was related to the difficulties in keeping the process model updated in the intranet. They perceived difficulties in detecting malfunctions of the DM model and acting correctly upon them.

Further barriers to implementation were related to the time and costs necessary to develop the IT system, and variations between the use of IT to generate and exchange information in different company’s projects. While some projects have all designs being fully developed with the use of CAD systems, and the design offices have fast intranet access which allows the easy exchange of information via web, other smaller projects still are not developed in electronic format, and consultants have difficulties in exchanging information via the web. Such differences were perceived by the model designer to also be a barrier to the model use as they impose difficulties to the design managers in terms of controlling and coordinating information exchanges. A final issue observed was the existence of information technology adverse people within the company. This was an apparent barrier to the process model use, as the model was to be published and kept updated in the intranet only.

![Figure 5.9: Force field analysis: factors affecting implementation related to people issues](image-url)
Figure 5.9 presents the driving/enabling and restraining forces related to the people issues in Company D. The main drivers of implementation were the IBP team ability to achieve buy-in and commitment from the top and regional managers and model users, as well as involving the right people with implementation. Buy-in was successfully achieved from top management, but regional managers’ buy-in was not appropriately sought in the beginning of the IBP programme and as a consequence it was poor prior to implementation. In this way, it is possible to state that regional managers were the ‘right people’ to be involved with the implementation, but as they were not appropriately involved and committed, barriers occurred.

The design managers need to have appropriate skills and capability for implementation. Therefore, having clarity of roles and responsibilities of design managers, the availability of appropriately skilled design managers, and having a clear vision of what the company is trying to achieve with the model use are main issues. The model designer stated that design managers need to have enough technical competence to absorb the DM model content, and to understand how they could best exploit the information within it for each project. Even though these were perceived as important enablers, they in reality represented barriers as lack of clarity on the roles and lack of a clear vision on what the company wanted to achieve effectively blocked pilot implementation.

In the same way, the lack of agreement with regards to the model aims by the top management, IBP management, regional managers and model user were also implementation obstacles, which were influenced by the existence of different sub-cultures throughout the company regions. Sub-cultures reflect different approaches with regards to how the company should manage design, which are conflicting to the idea of using the DM as a generic, company-level process model. As mentioned earlier, the design manager supposed that the model was going to be used to monitor his work, providing excessive control power to the company, and that was a major blocker to pilot implementation. In this way, corporate and individual interests were conflicting, which negatively affected implementation.

Conjectures about the usefulness of the model content, i.e. lack of trust on the process model ability to improve design management, coupled with conjectures about the quality of the information used to build the model and poor trust on the model designer
were further issues that acted as barriers for the DM model implementation. Difficulties in adapting the model to the project context were also pointed out by the design manager as reasons for not attempting to use the model.

Finally, lack of motivation by both the model designer and the model user was identified. The model designer was not motivated to assess the feasibility of transferring knowledge through the DM model, to plan implementation, to provide training or to help resolving implementation difficulties. This happened as the model designer was about to retire. In addition, the model user was not motivated to implement as he did not see benefits in adopting the DM practices, in planning implantation or in understanding the implications of using the model.

![Force field analysis chart](image)

**Figure 5.10: Force field analysis: factors affecting implementation related to the organisational and project context**

Figure 5.10 presents the driving/enabling and restraining forces related to the organisational and project context in Company D. A factor driving implementation from the organisational context is the support from top management. As it was stated by the IBP manager and the quality assurance, the fact that top management understood the impacts that design has on the company as a whole was the main driver for the DM
model design. Similarly, the high variability between project results in terms of financial losses generated great internal pressures to improve design management and consequently the quality of design. These issues made the decision to design and implement the DM model seem relevant and important.

Nonetheless, many issues affected implementation negatively from the organisational perspective. Inconsistency of management philosophies between the company regions, excess of power of the project managers, and the fact that each company region is self-contained are organisational characteristics that negatively affected implementation.

The lack of a clear and agreed company wide design management strategy, coupled with the lack of clarity on the design managers’ role also hampered the DM model use. Other restrainers were design process variability, which generates difficulties in adapting the model and keeping it relevant over time, as well as lack of time, i.e., projects with tight deadlines. The lack of continuity between the teams involved in projects (i.e. bid team and construction team are different), as well as the lack of a clear structure within the project teams were further barriers. Nonetheless, it is not possible to state if those are effective barriers or not as the model was not been implemented.

Figure 5.11 describes relationship between the implementation actions and the main driving and restraining forces acting upon the process model use in Company D.

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**Figure 5.11: Implementation actions, driving and restraining forces in Company D**

- □□□ = driving force; □□□□ = proposed actions; □□□□ = Restraining force
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Difficulties related to the implementation process are referred to as measures of implementation stickiness. Company D perceived measures of implementation stickiness were:

- the process model content is considered complex due to the excessive level of detail in which it is presented, generating difficulties in adapting it, therefore causal ambiguity occurred;
- there were easy communications between model designer and the user that would pilot implement the model, though communications between designer and other users were inexistent;
- there was a high degree of conjecture about the process model content as it was not considered internally both useful or applicable;
- both the model designer and the future user lacked motivation to implement, the first due to the fact he was soon to retire and the latter mainly due to conflicting interests with the organisational level;
- the source of information used to design the model was not perceived as reliable by the design manager who would pilot implement the model; and
- barren context was clear through the divergent regional views and interests over the DM model use.

It is also believed that lack of absorptive capacity of the models users could be providing further implementation difficulties as most of the companies design managers do not have appropriate knowledge on the design process, but this assumption could not be supported or refuted by the case study data as the model was implementation was rolled out throughout the company.

5.2.8 Discussion: hypotheses H5 and H6

The data analysis for Company D provides support for the research hypothesis 5: H5: Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy.
The factors affecting the transmission, absorption and use of the process model at Company D have been identified, as described in section 5.2.7. However, these were not readily available at the company, and as a consequence, they have not been discussed by the company members involved with implementation. As a result, no strategy to reduce the negative effects of implementation barriers or to exploit the beneficial influence of drivers and enablers was considered, and no action was taken. Therefore, it is possible to state that the factors were not appropriately identified nor managed at Company D, and implementation was unsuccessful.

Regrettably, Company D’s data did not provide enough evidence to support or refute hypothesis 6: **H6**: Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects that companies in which generic model is not continuously and explicitly updated.

As described in section 5.2.5, the company has placed great importance on the need of updating the model accordingly to specific project experiences. Due to the fact that the model has not been successfully pilot implemented, it could not be updated on the basis of its application at the project level, and consequently not replicated through the company.

### 5.2.9 Summary of key findings

The main triggers for the DM model implementation were to achieve consistency in all projects (i.e. successful financial outputs) through achieving a common understanding of design management throughout the company, enabling the use of similar managerial principles and enabling control over design development. The model was also designed to allow supporting the skills development for the company design managers.

The outcomes of implementation were unsuccessful, mainly due to divergent perspectives on design management and on the process model by the top management, regional managers and design managers throughout the company. Lack of definition of the benefits for the model users, lack of involvement of users during the model design, lack of an appropriate definition of the implementation strategy and general mistrust, were the main causes identified.
The knowledge content of the process model also negatively influenced its use. The DM model is not applicable to different business areas of the company (i.e. civil engineering), the model lacks clarity with regards to the links between design management, bid management and the main project phases, and it is not credible for both regional managers and users.

The company has not formulated an appropriate strategy to support the use of the model from the beginning of the effort. The steps identified for the process model design and implementation broadly included identification of the improvement need, top management engagement, selection of improvement areas and formation of teams, process analysis, design of the model and procedures, definition of the implementation strategy, pilot implementation, buy-in, training and roll out implementation. Due to the problems above mentioned, the model was not pilot implemented.

Finally, the factors affecting implementation both negatively and positively were identified, but not systematically described by the company or acted upon. The identified factors focused on communications, implementation strategy, use of information technology, people issues and the organisational and project context. Difficulties were identified with regards to causal ambiguity, arduous relationship, unproven knowledge, model designer and users lacking motivation, source not perceived as reliable and barren organisational context.

### 5.3 Summary and link

This chapter presented the data collected and analysed for the main, in-depth case study developed in this research. A narrative describing triggers, the implementation content, implementation process, and the main outcomes in Company A was presented. Findings supporting or refuting the research hypothesis were discussed for the case.

The next chapter presents the cross-case analysis of the case study data.
6 Cross case analysis

6.1 Introduction

This chapter presents the cross case analysis, discussing the research hypotheses according to the analysis presented in chapter 4. Therefore, issues relating to the implementation triggers, process, and outcomes are discussed. The chapter concludes by presenting the proposed typology for implementation drivers and enablers, along with the measures of implementation stickiness.

6.2 Implementation triggers

Similar drivers for implementation have been identified across all case study companies, and these tend to be consistent with the espoused benefits of using process models described in the literature (see sections 4.2.1, 4.3.1, 4.4.1 and 5.2.1). With both the exploratory and main case studies it was possible to identify benefits for the organisation as a whole, for the PDP (or design/construction process) and for the final client.

This demonstrates that within the case study companies there was real belief that such benefits could be accomplished. In this way, it is possible to state that all companies had an emphasis on the causal correlation between having a process model and control and rational decision making as means for improving PDP management. All companies achieved top management support through a detailed identification of the problems and description of benefits to be accomplished through the use of a process model.

Nonetheless, each company had slightly different explanations for the use of process models, which were directly related to the principal motive that triggered each initiative. In Company A, focus was given to reduce PDP managerial problems by establishing a single, company wide generic ‘best practice’ on product development management (see section 4.2). Company B developed its process model to provide a framework for an alliance with a client and other construction organisations (see section 4.3). Company C aimed to support the delivery of partnering agreements with five major contractors (see section 4.4). Finally, Company D aimed to achieve consistency in all projects through improved design management (see section 5.2). All companies initially intended to
reduce problems through improved processes and to allow for process control. Table 6.1 summarises the primary and secondary focuses of the process model design and implementation across the case study firms.

<table>
<thead>
<tr>
<th>Focus of process model design</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide one generic best practice</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce PDP problems</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Framework for alliance/partnering</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Shared process understanding training</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Improve planning and control</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Achieve consistency and success in all projects</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Reduce risks</td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Meet client requirements</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve communications</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Key: 1 = primary focus; 2 = secondary focus

6.2.1 The concept of ‘process’ in the case study firms

The concept of process is understood across all case study companies as being the transformation of inputs (i.e. information or materials) into specific outputs. Also, all companies acknowledge that there are flows of information within processes, and that ultimately the aim of a process is to generate value to customers.

However, all process models analysed describe the process (be it product development, the design and construction, or design management) as transformations of inputs into outputs, and little attempt is made to describe information flows. Also, all models represent the process subdivided into parts, and consider that these can be managed as if they were discrete processes in themselves. Coordination structures representing actors and information exchanges are not appropriately considered. These shortcomings reflect limitations which can also be found in the process models presented in the literature (see sections 2.2.3 and 2.4.6).

Furthermore, the value generation aspect of processes appears not to be appropriately contemplated by the companies, as it is not explicitly considered in any of the models.
analysed. Apart from Company A (the out-of-industry case), none of the construction firms directly addressed improving the quality of the final product as one of the objectives of the process model design.

Finally, the concept of a generic process model was not clear within Company B. As described in section 4.3.1, a ‘generic process’ was referred to as being the project stages solely, and no reference was made to process activities, information flows, deliverables or stakeholders. Considering that the interviewee is a middle manager of the company, responsible for process improvement initiatives, the lack of clarity in the understanding of generic processes was surprising!

### 6.2.2 Improvement actions proposed in the models

The process models from all companies can be classified as ‘to-be’ models (see section 2.2.3), which describe to a greater or lesser degree tools for improved process management. All maps represent the process through a set of phases, describing activities, functions and deliverables, and present a hierarchy of different levels of detail, e.g. whole process view, activity and task levels.

Apart from Company B’s materials purchasing model (see section 4.3.1), all other models analysed attempt to represent a holistic view on the product development or design and construction process (see sections 4.2.1, 4.4.1 and 5.2.1). Therefore, most of the models describe process activities from recognition of the need until the operation of the facility. Also, all models represent some form of redesign of the sequencing of these activities, but no attempts are made to introduce concurrent engineering concepts (i.e. designing the product and production systems concurrently or overlapping design stages to reduce lead time). The introduction of concurrent engineering concepts was attempted only at Company A, but it was abandoned as the company reported extra costs associated with greater process complexity (see section 4.2.1).

All the process models define reviews throughout the process, being in some cases linked to the end of each project phase. The concept of phase reviews appeared to be the most easily applicable improvement associated with the process models at the case study companies. Phase reviews were considered in all cases beneficial as they provide
for appropriate control over the production of project deliverables at both the project and organisational levels.

The process models from Company A, C, and D were developed considering the use of technological solutions for collaboration, i.e. project intra or extranets and engineering databases or repositories of information. Therefore, there is a strong link between the introduction of a new process model and the implementation of enabling IT solutions within most of the case study companies. Even though this is considered in all companies as beneficial, it has been identified that it provides extra complexity for the implementation process (see sections 4.2.7, 4.4.7 and 5.2.7).

Finally, as mentioned in section 6.2.1, little attempt has been given at all companies to achieve better value for the client through the process. This demonstrates a far greater focus of process models as means to improve product development outcomes internally, as opposed to means to provide better value to customers. Even though the importance of focusing on clients’ needs to deliver better quality throughout the industry have been largely discussed in the literature (see sections 2.2.1, 2.2.3, and 2.2.5), the appropriate consideration of this issue is still not apparent in the case study companies. The driver for achieving financially successful project outcomes for the company has prevailed over the importance of meeting client’s needs. The real purpose of any process is to provide value to customers, and this concept appears to have been eroded in process models in practice.

This might be related to the fact that an effectively managed process does not necessarily lead to a better quality product. Process models, however, provide different building blocks that can potentially bring about better value generation for the client. Such building blocks could be, for instance, for assuring that sufficient time is reserved for client requirements capture, securing that design alternatives are developed (e.g. set based concurrent engineering approach, Sobek et al., 1999). Also, the building blocks could be for providing better information exchanges to support joint solutions by designers from different disciplines.
6.2.3 Applicability and usefulness of process models at the case study companies

The framework to evaluate the applicability and usefulness of process models with a view to implementation has been validated based on the findings from Company A, as this was the only case in which the process model has been successfully implemented (see sections 3.7.2). The concepts of a process model applicability and usefulness were then used to assess the models from companies B (see section 4.3.3), C (see section 4.4.3), and D (see section 5.2.3).

At Company A, lifecycle management is considered both applicable and useful (see section 4.2.3). The model is flexible as it is adaptable to different business units and project types and sizes, and is regularly updated. It is easy to use, as it has a clear and simple presentation structure, which provides clarity in terms of its knowledge content. The model is credible, as most users accept it helps PDP management, and it provides for the discussion of scenarios and problems, allowing people to think over the process before executing it. The model has been validated through pilot implementations. Throughout more than ten years of experience of using process models, the company realises that a process model will be only successfully used if it is approached as a ‘learning’ tool, as opposed to a hard ‘planning and control’ tool.

Table 6.2 provides a summary describing the results of the evaluation of the process models applicability and usefulness at the construction companies that participated in this research. The results presented are discussed as follows.

Flexibility is not a feature of the models developed at both Company B and C. At Company B, the model focuses on a specific alliance instead of the whole company, and difficulties in adapting it to different business units and different project sizes have been identified. For Company C, the model is sufficiently generic and flexible to be applied to different types and sizes of projects. The models are supposed to be updated regularly, but continuous improvement strategies were not explicitly described in any of the cases.

All companies have carefully considered their models’ presentation structure. The importance of simplicity and clarity on the model presentation for successful uptake has been explicitly emphasised. In all cases the models were published (or were to be
published) in the company’s intranet sites for easy access. Nonetheless, the models had shortcomings with regards to the clarity of their knowledge content. At both companies B and D there was lack of clarity between the process model and other company documentation and guidance. At Company C, problems regarding different interpretations of the model content due to differences in the language used throughout the company were identified. At Company D, the model lacked clarity in the links between the whole process stages and design management stages, and roles and responsibilities were not clearly defined. Also, difficulties in understanding its knowledge content due to inappropriate design management skills were identified.

Table 6.2: Applicability and usefulness of the models at the construction case study companies

<table>
<thead>
<tr>
<th>Headline criteria</th>
<th>Attributes</th>
<th>COMPANY B</th>
<th>COMPANY C</th>
<th>COMPANY D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Generalsable to different areas</td>
<td>No</td>
<td>Yes (predicted)</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Updated regularly</td>
<td>Has been updated but it is not continuously done</td>
<td>Yes (predicted)</td>
<td>Difficulties in updating project experiences</td>
</tr>
<tr>
<td>Easy to use?</td>
<td>Presentation and structure (simple and clear)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Clarity of the model content</td>
<td>Lack clarity between model and other documents</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Credible?</td>
<td>People believes it helps management</td>
<td>No (predicted)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Provides for scenarios and discussion of problems</td>
<td>Yes</td>
<td>Yes (predicted)</td>
<td>Yes at the company level, but not at project level</td>
<td></td>
</tr>
<tr>
<td>Credible?</td>
<td>Model role agreed</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Valid?</td>
<td>Applied in pilot implementation</td>
<td>No</td>
<td>Yes (to be implemented in 5 projects)</td>
<td>No</td>
</tr>
<tr>
<td>Appropriately describes process</td>
<td>Model does not clearly represent when reviews are to be done</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurable?</td>
<td>Performance indicators</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

It is possible to state that in all the case study construction companies there was a belief that by having a clear presentation structure, the knowledge content of the models would be easily understood by all stakeholders. This demonstrates that the companies have under estimated the effort needed to transfer explicit as well as tacit knowledge to
allow stakeholders to understand the complexities involved throughout the PDP as well as the content of new practices being introduced.

It is likely that one of the adverse consequences of the poor transfer of knowledge from the model developers to the model users was the low user acceptability (or lack of credibility), identified in all construction case study companies. At Company B, managers perceived to lose bargaining power over other stakeholders (namely, the alliance partners) by the adoption of the model, and that was a major implementation barrier. At Company C, difficulties were identified in terms of conjectures about the model representing good practices which effectively support better design management. Thus, even though the models provide for the discussion of different scenarios with regards to the project execution in both cases, user acceptability was low. Finally, at Company D, lack of credibility of the model designer and perceived poor quality of the information used to design the model directed to lack of user acceptability. Even though the user was involved with the process model design, he had no power in terms of changing strategic directions taken, which therefore influenced his acceptability level.

In this way, it is possible to state that the models of all three construction companies presented shortcomings with regards to their applicability. These shortcomings related to poor model flexibility (companies B and D), lack of clarity on the model knowledge content, and poor credibility in terms of lack of user acceptability.

The process models of the three companies also presented shortcomings with regards to its usefulness as perceived by model users. The role of the process model within the company has not been agreed with users in any of the cases. Also, at all companies there was an assumption that the models were to be used as a basis for control. Company B focused on providing control for one specific type of project, and as such, the model role has not been discussed throughout the company. At Company C, the role of the model as means for planning and control was to be explicitly imposed by mandating the model’s use. At the main case study, the consequences of the lack of agreement of the process model role within the company became apparent. There were conflicting views between regional managers not only with regards to the role of the process model but, more importantly, on the role the company should have in managing design. This, in effect, undermined the use of the model.
The lack of agreement on the role of the process model within the companies is a surprising outcome of the case studies. It was expected that the role (as part of the main aim of the process model) would have been agreed in the company before the investment of time and resources into the model design, but as the case study data showed, this was not the case.

The construction company’s process models analysed also demonstrated limitations in terms of validity. None of the models were effectively validated through pilot implementations, but Company C’s model was to be piloted in the near future. At the main case study, pilot implementation was hampered by the design manager’s lack of credibility on the model content. Furthermore, at companies B and C the models had deficiencies in terms of clearly representing the process, as in Company B phase reviews were proposed but when they should occur was not made explicit, and at Company C the model did not clearly described proposed changes to current practices.

Even though the models devised for companies B and C presented performance measures attached to them, none of them presented measures effectively describing improvements accruing from the model use. Once again, this reflects a shortcoming in the literature, which has not explicitly described indicators to measure improvements achieved through a process model use in practice (see section 2.3).

In summary, there appears to be an emphasis within the case study companies on the design of the process model, and no appropriate consideration has been given to its use. This is evidenced by the shortcomings identified in the evaluation of the models usefulness and applicability at the case study companies. An emphasis was identified at defining an appropriate presentation structure for the models. However, this was emphasised without the appropriate definition and agreement of the model’ role within each company and without suitably considering the importance of user acceptability for successful PDP models implementation.

The next section describes research hypotheses related to the implementation triggers and outcomes, presenting evidence to support or refute them with the basis on the data gathered and analysed in the case studies.
6.2.4 Hypothesis 1: Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful

The analysis of the data from the three exploratory and the main case study developed as part of this research provides support for hypothesis 1.

In Company A, implementation was only successful when the model was simple and flexible, being regarded as applicable and useful by its users. The case study also showed that an over detailed model could not be successfully implemented (i.e. the model developed through IDEF0 methodology) as it became inflexible and, therefore, was not applicable at both organisational and individual levels. In this case, a model which was not considered applicable and useful could not be successfully implemented, and conversely, a useful and applicable model achieved successful implementation outcomes (see section 4.2.4).

At Company B, implementation of the model as a whole was not successful. The evaluation of the model demonstrated shortcomings both in terms of its applicability and its usefulness (see section 4.3.3). Flexibility is not a feature of the model as it cannot be applied throughout the company. Further, the model lacks credibility at the individual, user level. User acceptability was not achieved as middle managers perceived loosing power by using the model, and as a result of the lack of validation through pilot implementations. In this case study, the model was neither appropriately applicable nor useful and its implementation was not successful (see section 4.3.4).

Data from Company C does not support or to refute hypothesis 1. This is due to the fact that the implementation effectiveness could not be assessed as the PDP model was still under design by the time the exploratory case study was conducted (see section 4.4.4).

Finally, Company D’s model evaluation made limitations clear in terms of applicability and usefulness at both organisational and individual levels. Lack of agreement of the model role at the organisational level made implementation unfeasible. At the individual level, conjectures with regards to the usefulness of the model coupled with a lack of perceived benefits accruing from the model use blocked pilot implementation. In
this case, the model was not regarded as applicable or useful, and implementation was unsuccessful (see section 5.2.4).

In summary, it is correct to state that efforts to implement process models in which the model is applicable and useful will present higher effectiveness than efforts in which the model is considered to inapplicable or not useful.

6.2.5 Hypothesis 2: Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use

The case study results do not provide enough evidence to support or refute research hypothesis 2, but indicative data to refute it was identified, and this is an unexpected outcome of the case studies. All process models had performance indicators attached to them. Nevertheless, in most cases, the measures have not been exploited or populated with real project data. Different reasons for that were identified, and are described as follows.

Company A’s model had performance measures (other than overall cost and time), which were used but subsequently abandoned due to two factors. First, there were difficulties in measuring the PDP in a way that could be comparable between different business units. Second, and most importantly, the company faces difficulties in keeping performance measures aligned with the business needs and functions, due to constant business changes. It is interesting to note that at this case study, difficulties in measuring benefits resulting from the process model use did not have any influence over implementation success, which is not in favour of H2 (see section 4.2.4.3.1).

In Company B performance measures were attached to the materials process models (see section 4.3.1). Even though the importance of adopting measures throughout the process was highly emphasised, there is no evidence available (e.g. through documents) to corroborate the use of the measures in practice. In this case, improvements achieved through the model use were not measured as the implementation was unsuccessful (see section 4.3.4). The process model designed within Company C also presents
performance indicators attached to it. Nonetheless, those measures were not used in the company as the model was not yet implemented at the time the case study took place (see section 4.4.4).

The main case study company presents a slightly different situation, as a number of performance indicators were used, but none of them focused on measuring design (both product and process) or evaluating the process model use. Therefore, this case does not provide enough evidence on the effects that difficulties in measuring performance could had on the implementation outcomes (see section 5.2.4).

In summary, it is not possible to verify or refute the hypothesis that efforts to implement process models in which improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which there are difficulties in measuring the benefits resulting from the process model use. Interestingly, there is indicative evidence to refute hypothesis 2, as Company A’s implementation was successful even though no measures of performance effects were adopted.

6.3 Implementation process

6.3.1 Considerations on the organisational, group and individual change levels

The successful implementation of a PDP model involves changes that occur at organisational, group and individual levels (see section 2.4.3). This statement is supported by the data gathered and analysed for Company A. At this case study, implementation could only be successful when the change needed was considered throughout the three levels.

The strategy for the implementation of Company A’s PDP models was holistic in nature, as it considered the interactions between the different company sub-systems, including internal business units and external, market pressures, thus addressing the organisational change level. Training was not approached as the sole mechanism for change. Conversely, change was initiated by the model users’ involvement in designing specific models for each of the company business areas. This strategy leads to increased learning and commitment to the model use. This process allowed the views of each of
the different groups involved with the implementation to be agreed and adjusted to create specific models. Finally, the implementation strategy considered that the basis for all change resides in changing behavioural patterns of employees. This is evidenced by the importance given to motivation and clearly demonstrating benefits not only for the organisation but also for each process model user (see section 4.2.5).

Conversely, at the construction case study companies, not enough consideration was given to the change needed at the individual level. Even though all companies acknowledged individual behaviour as the basis for change, this has not been appropriately considered in the implementation strategy (see sections 4.3.5, 4.4.5 and 5.2.5). It was not possible to identify explicit mechanisms for creating and sustaining motivation of the process models users in any of these case study companies. In fact, at Company D, lack of motivation and the perception of lack of individual benefits hampered the model pilot implementation. Furthermore, at companies B and D there was a perception that the model implementation would result in excessive control of the company over individual actions.

Therefore, the principles of classic or scientific – rational school of organisational management still appear to be applied in practice, in which change has been directed into increasing control over individual actions, ensuring they subordinate to corporate interests. The aim of achieving maximum efficiency (not necessarily efficacy) is still present, and no significant mechanisms for adaptation are present in the construction PDP model implementation initiatives analysed. Change is therefore planned at an operational level, but without the appropriate understanding of the reality of the operational activities and of the appropriate level of change needed to achieve improvements.

### 6.3.2 The planned approach to change taken by the case study companies

As initially expected, each of the case study companies has developed its own strategies and steps for designing and implementing their PDP models, and has reached different implementation success levels. Yet, some similarities across the companies could be identified, and are described as follows.
Firstly, all companies have explicitly determined the espoused benefits of designing and implementing their PDP models as an initial stage, and have proposed the adoption of improved managerial practices (see section 6.2). The expected goals of (re)design were thus established.

Secondly, none of the companies have used explicitly defined criteria to evaluate the merit of the process models developed internally. However, at all the companies, the models were intuitively evaluated by groups of managers, or in the case of companies A and D, by some future model users (see section 4.2.5, 4.3.5, 4.4.5 and 5.2.5). This demonstrates the importance and need for such evaluation during the models’ design and prior to implementation. The fact that the evaluations were unstructured and intuitive may be related to the lack of availability of a framework to perform such evaluation. Therefore, the framework to evaluate process models with a view to its implementation can constitute a contribution of this research to practice.

Thirdly, all companies have acknowledged the fact that implementation would involve a certain degree of model adaptation and subsequently its adoption to guide actions in the different project contexts, as predicted in the theoretical framework of this research (see Figure 2.8). Nonetheless, at all construction companies the models’ adaptation was not explicitly described or predicted in the model itself neither as part of training strategies.

Furthermore, none of the construction companies involved with this research had established an implementation strategy combining the model design and use, as represented in Figure 6.1. The companies defined the benefits and goals of the model, and then decided on the steps for the process model design, which included the establishment of a model design team and identification of process problems. At that point in time, no consideration at all was given on how the model would be implemented. Following that, process model was developed through an iterative cycles of design, dissemination and feedback.

As shown in Figure 6.1, the definition of the implementation strategy started to be thought of only after the models were designed. It is argued here that one of the main reasons for the lack of implementation success was the disjoint consideration of implementation and the process model design. A process model needs to be designed with a view to its implementation (see section 2.2.3), since a model that cannot be
implemented is worthless. As the models were developed without considering their use, a number of difficulties occurred. Users were not appropriately involved in the process, and issues related to the model use throughout the company were not thought. Also, difficulties in transferring the knowledge content from model designers to users occurred, and created difficulties in achieving model buy-in.

Furthermore, implementation strategy has not been appropriately formulated at any of the construction company case studies. The only issues considered involved the process model validation (at companies C and D, see sections 4.3.5 5.2.5 and 5.2.5), achieving buy-in (Company D, see section 5.2.5) and training (companies C and D, see sections 4.4.5 and 5.2.5). At Company B the inappropriateness of the strategy was even greater, as there was a belief that designing and disseminating the model would be sufficient for its successful uptake (see section 4.3.5).

All these problems have generated barriers that stopped the models being adapted to suit specific project needs. As the models were not adapted to the context in which they were to be applied, they were also not used to guide the actions of the project team. A number of difficulties in adapting the models for the project contexts were identified, and are described in section 6.4 as the measures of implementation stickiness.
6.3.3 Hypothesis 3: Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation does not occur

The analysis of the case study data provides support for hypothesis 3. On the one hand, at Company A, the model was adapted and adopted in the specific project context, and implementation was successful (see section 4.2.6). On the other hand, at the companies C and D, the generic process models have not been adapted to suit the needs of specific projects, and the implementation was not effective (see sections 4.4.6 and 5.2.6).

At Company A, the process model implementation was successful only after local variations of the process model were designed for each business unit of the company (see section 4.2.1). These local variations represent process model adaptation, from the generic and high-level company model to a business unit specific model. These business unit models are then used to guide actions of the project team. Nonetheless, no evidence was found to suggest that such models were used as a basis to devise project plans. Therefore, it can be stated that the business units specific process models provided for learning and were used as a ‘thinking tool’, through which project managers consider the specific necessities of each project. In this case the PDP model was adapted and adopted to guide actions of the project team, and implementation showed a high rate of success (see section 4.2.6).

At Company B, implementation was unsuccessful. The main reason pointed out for this was the excess of variability between projects, which would impose a great effort to adapt the model for each project (see section 4.3.2).

Company C’s model was to be piloted soon after the case study was developed; therefore it is not possible to assess the effectiveness of implementation. However, difficulties in adapting the generic model to suit specific project needs were identified possible barriers (see section 4.4.2).

Finally, at Company D, even though the design manager (model user) acknowledged that the only way to successfully implement the model would be through the creation of a project specific model, he did not perform the adaptation mainly due to divergent political directives coming from regional managers, as well as due to the fact that he
perceived to be allowing excess of power to the company in controlling his individual actions if the model was adopted (see section 5.2.2). Therefore, once more the process model has not been adapted and adopted in the project context, and implementation was unsuccessful (see section 5.2.6).

6.3.4 Hypothesis 4: Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP implementation and replication when compared to companies where future users do not participate in the model development

The data from the case studies provides support for hypothesis 4. At Company A, the generic process model has been developed in collaboration with motivated users, and the model implementation and replication showed a high rate of effectiveness (see section 4.2.6). Conversely, at companies B and D, the process models were developed without the appropriate collaboration and motivation of the future model users, and as a result the models were not successfully implemented (see sections 4.3.6 and 5.2.6).

In Company A, there was a great focus on involving users with the model design, generating collaboration, commitment, motivation and learning (see sections 4.2.1 and 4.2.5). The importance of collaboration has been realised in the company throughout the years, as implementation was perceived to be more successful where model users were effectively involved with the model design. Collaboration directed individuals to choices which are supportive of the process model implementation. This was achieved by both: (a) involving people with the generic process model design, giving users the opportunity to feedback on the main principles behind the model; and (b) through the design of specific business units’ models. Top management initially considered this inappropriate (as the resultant models were not applicable to the whole company), but it was later realised that this was an effective way to increase learning, motivation and commitment. At the strategic level, motivation was provided by the clear definition of organisational and individual benefits from the model use.

At Company B the process model users were not involved with its design, and they were not motivated to implement it as they perceived the model to present a threat to their bargaining power over other process stakeholders. Therefore, they did not have individual interest in taking actions to implement the model, and choose not to use it
(see section 4.3.6). It is not possible to support or refute hypothesis 4 on basis of the information provided by Company C, as it is not known if implementation was successful or not. However, low levels of collaboration with model users were identified (see section 4.4.6).

At Company D the model was not designed in full collaboration with its users. The belief that the model would be used for control rather than for process improvement severely hampered the design manager’s motivation to implement it. Certainly, lack of involvement of the company regional managers in the strategic definitions of the model objectives and role in the company hindered the model buy-in and consequently its implementation. Therefore, low levels of collaboration between model developers and users and low levels of motivation to use the model directed to unsuccessful implementation outcomes in Company D (see section 5.2.6).

6.4 Implementation content

This section describes issues on the transfer of the knowledge embedded in a process model from its developers to the model users, which are discussed in terms of factors that affect the transmission, absorption and use of PDP models. A typology for classifying drivers and enablers has been proposed based on the case studies findings. Implementation restrainers were classified accordingly to the proposed measures of difficulties in implementation, or implementation stickiness.

6.4.1 Implementation drivers and enablers

The implementation is seen as a process, not a one-off activity, in which an organisation reorganises and creates a set of new, improved practices, which are supposed to become new organisational routines. Different activities take place to allow a PDP model content to be transferred, absorbed and used in practice (see section 6.3), and diverse forces affect the effectiveness of such activities. In this section, the forces that were perceived to make implementation possible and easier in the case studies are discussed. These have been classified as drivers (which allow and/or facilitate a PDP model use in practice) and enablers (which make implementation easier). Such forces also represent implementation difficulties (see section 6.4.2).
It is acknowledged that the importance of some of these beneficial forces will be noticed easily by those involved with implementation, and will be considered (maybe as common sense) as part of the implementation process. However, the consideration and management of these beneficial factors may exceed the initial vision of the actors directly involved with implementation. Therefore, it is believed that the assessment and explicit description of such forces is valuable for pointing out good practices. Making such drivers explicit can help achieve greater success in future implementation efforts.

The implementation drivers and enablers identified at the exploratory cases (A, B and C) were organised accordingly to their influence over each aspect of implementation (i.e. triggers, model content, process and outcomes), see Table 4.1, Table 4.4, and Table 4.6. Company D’s data made possible the classification of drivers and enablers accordingly to a typology which emerged during coding (see Table 5.3). This typology was then used to classify the drivers and enablers for all case study companies. Table 6.3 summarises these findings. Factors related to the effectiveness of communications, the implementation strategy itself, the use of IT to enable the model use, people issues and the influences from the organisational and project context are described as follows.

Table 6.3: Summary of the main drivers and enablers affecting implementation triggers, content, process and outcomes at Companies A, B, C, and D

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Triggers</th>
<th>Content</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>• communicating benefits of change (B)</td>
<td>• consider user requirements in model design (D)</td>
<td>• internal marketing (D)</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• publishing the model in a user friendly, simple format (A, B, C, D)</td>
<td>• face to face interaction: designer and users (D)</td>
<td></td>
</tr>
<tr>
<td>Implementation strategy</td>
<td>• support from top management (D) • objectives clearly defined (A, D)</td>
<td>• phase reviews enabling proactive problem resolution (B, D)</td>
<td>• agreed implementation strategy (A)</td>
<td>• no evidence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• lessons learnt available (B) • route map for improvement (C)</td>
<td>• clearly defined team (A, B, C) • training (A, C, D)</td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>• no evidence</td>
<td>• no evidence</td>
<td>• information easily accessible - available (C, D)</td>
<td>• no evidence</td>
</tr>
<tr>
<td>People</td>
<td>• buy-in from regional management (D)</td>
<td>• all comprehend priorities (A)</td>
<td>• involve right people (D) • motivation to design and implement (A)</td>
<td>• no evidence</td>
</tr>
<tr>
<td>Organisational and project context</td>
<td>• top mgmt understanding design impacts (D) • alliance (B) • partnering (C)</td>
<td>• no evidence</td>
<td>• support from a consultancy company (B)</td>
<td>• no evidence</td>
</tr>
</tbody>
</table>
### Table 5.3 (continued): Summary of the main drivers and enablers affecting implementation triggers, content, process and outcomes

<table>
<thead>
<tr>
<th>Enablers</th>
<th>Triggers</th>
<th>Content</th>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>• holistic process view by all (B) • same principles applied to all projects (C)</td>
<td>• no evidence</td>
<td>• present model when it has enough information to attract interest (D) • end user involvement/ feedback model design (A, D) • user groups to analyse impl. (A)</td>
<td>• common understanding by all (A, D) • information easily assessable to all (B, D) • process allowing different cultures to merge (C)</td>
</tr>
<tr>
<td>Implementation strategy</td>
<td>• clear scope, inputs / outputs for implementation and process requirements (A) • process analysis from high-level through to detailed procedures (B) • not allow duplication of work (B)</td>
<td>• model not too detailed (A) • key principles (A) • integrating people process and IT (A, D) • defining process deliverables (B) • consensus in model design (C)</td>
<td>• phased implementation at local levels (A, B) • pilot (A, C) • workshops to enforce need for the model (A) • key deliverables of model design and implementation (B) • flexibility (A, B, D)</td>
<td>• maintaining and updating the model, including people and IT (A, B, D) • monitoring and measuring success through KPIs (B, C, D)</td>
</tr>
<tr>
<td>IT</td>
<td>• no evidence</td>
<td>• easy to visualise through IT (B, D) • common information systems (B)</td>
<td>• networking secure areas (D) • create routine on using the model by inputting project info on the system (D)</td>
<td>• project processes (all specific project information) in the IT system (D)</td>
</tr>
<tr>
<td>People</td>
<td>• commit managers and users (D) • clearly demonstrate, and understand benefits of change (A, C)</td>
<td>• have a person responsible for the process (A)</td>
<td>• leadership from project manager (A) • define ownership in the beginning (A) • leadership and capability: model designer (A, D) • training (A, B, D) • involve users (B)</td>
<td>• team dynamics to cope with variability at business and market level (A) • analysing value added by the model (B) • support from senior mgmt (A)</td>
</tr>
<tr>
<td>Organisational and project context</td>
<td>• need to improve PDP (D)</td>
<td>• no evidence</td>
<td>• well structured project teams (D) • organisational slack (B, D)</td>
<td>• no evidence</td>
</tr>
</tbody>
</table>

### Drivers and enablers affecting implementation triggers – implementation strategy definition

Drivers and enablers affecting implementation triggers are factors that make it easy to recognise implementation opportunities or forces supporting the initiation of a PDP model implementation. The implementation opportunity exists as soon as the need for increased PDP performance is perceived. Performance gaps may prompt the search for solutions, which might uncover superior practices that could be achieved through the design and use of a PDP model.
The definition of the implementation strategy is related to finding both a gap and the knowledge to fill that gap (i.e. the appropriateness of a PDP model in closing the gap). As described in section 6.3.2, the construction companies have had a number of difficulties in the definition of the implementation strategy. Also, an excessive focus has been put into determining what was needed for the design of the process model, but not enough consideration was given to defining strategies to bring about its successful use. Therefore, the appropriate consideration of issues on the model use prior to its design is considered to be extremely important for successful implementation.

One of the identified drivers related to the implementations triggers is clearly communicating the benefits of change throughout the company, with a special focus on top management and on the process model users. The case studies made it clear that top management should understand the impacts of a badly managed PDP, and consequently provide overall support for implementation. This, in turn, helps to create an organisational environment which encourages the model use. In this way, the clearer the model objectives are from the start, the better. The importance of achieving buy-in from managers of different regions early in the process was made explicit at Company D, in which the late involvement of such managers, and poor buy-in, stopped implementation and impinged late changes on the PDP model (see section 5.2.7). In terms of achieving a supportive organisational context, linking implementation with other initiatives, such as strategic alliances and partnering, were further implementation drivers.

Emphasising the importance of achieving a shared, holistic process view by all stakeholders, and clearly describing that the model represents a set of principles that should be applied to all company projects were factors enabling the implementation strategy definition with regards to communications. This was important at Company A (see section 4.2.7) as it made the aim of the model explicit for its users, and that was related to process improvement overall as opposed to control of individual actions. Factors enabling the implementation strategy were the clear definition of the implementation scope, process requirements (in terms of improvements to be introduced), and the establishment of implementation inputs and outputs at a strategic level. A further enabler was undertaking a detailed process analysis from the high-level model through to procedures.
Finally, no factors related to information technology were found to be positively affecting the implementation strategy definition. Nonetheless, at Company D, the process model design has been triggered by an overall improvement initiative, which also focused on the introduction of new IT systems.

Factors enabling implementation with regards to the model content were related to the implementation strategy and to the use of IT to enable the model use. The process model being designed describing key improvement principles integrating process, people and IT, and describing specific deliverables were identified as implementation enablers. This demonstrates the importance that having a *generic* model has on implementation success. As described in section 4.2.2, at Company A, implementation success could only be achieved when the model designed was generic, and a detailed process model could not be implemented. Therefore, importance should be given to the definition of the high-level process principles as opposed to the definition of detailed activities as a means to enable implementation success.

Finally, the use of IT as a tool to publish the model was identified as a further enabler relating to the model content. IT helps implementation as it makes the model easily accessible to all. Furthermore, publishing the model in a web based structure makes it easy for the user to navigate from the high-level model to the description of activities, procedures or guidance. Even though, these benefits can only be achieved if all stakeholders have access to a single information system, e.g. at Company C, all companies involved in partnering need to get access to Company C’s intranet to be able to visualise the process model (see section 4.4.7).

**Drivers and enablers affecting implementation related to the process model content**

After the design and implementation of a process model has been decided in the company, attention shifts to the PDP model design and its content, as the model is the object to be implemented. The careful planning of model design activities happens at this stage, as identified at all case study companies (see sections 4.2.3, 4.3.7, 4.4.7 and 5.2.7). The quality of the knowledge content of the process model is of clear importance for the success of the implementation effort. Therefore, it is extremely important that users perceive that the model being designed is of a high calibre and effectively proposes improvements to the company current PDP practices.
The suitable communication of the process model content was identified as one of the most important implementation drivers. Great emphasis was given to designing and publishing the PDP models in a user friendly and simple format to allow the easy absorption of the model content by users. Also, explicitly demonstrating that user requirements are considered during the model design helped decreasing speculations about the appropriateness of the model in terms of improving current practices.

Approaching the process model as a ‘road map’ introducing good practices such as phase reviews and describing lessons learnt in past projects were factors further driving success where considered as part of the implementation strategy. In terms of people issues, the process model should not blur the appropriate understanding of the priorities of each project. Company A case made explicit the need for implementation to start by through such understanding, which allows the model to be adjusted the to the project context.

** Drivers and enablers affecting the implementation process**

After the process model has been designed, attention is focused to the model use at the project level, which involves the exchange of information between model designer and users. Planning tends to be used to avoid the recurrence of problems that the company faced in past implementation attempts. In this way, the introduction of new knowledge and new practices was more feasible.

Factors driving the implementation process have been identified at all five categories of the proposed typology. Creating means for face to face communications between the model designer and its users was considered a driver as it allows for the transfer of tacit knowledge involved in the process. This also helps bridging the communication gap, which is required to solve problems relating to language and cultural differences.

As Company A made explicit, implementation affects the normal activities and therefore may cause disruptions and even delays in some projects. Therefore, it is important to agree implementation at both organisational and individual levels, with top management, model designers and users. Agreeing the strategy should include evaluating when resources would be made available for training. A further implementation driver was creating an implementation team, which was involved in the
model design and made available to support individual implementation attempts. At Company A, such team is also responsible for training in a one-to-one basis. This team was responsible for identifying people beneficial for implementation throughout the company (usually at higher managerial levels), and generate buy-in as far as possible. Higher management buy-in has helped increasing the motivation of model users (Company A). At Company B, having the support of a consultancy company during the process model design was considered essential, as no internal resources were made available to execute model design related activities.

Implementation process enablers were also identified for all categories of the typology proposed. In terms of communications between model designers and users, having constant involvement of users during the model design was considered essential to improve and increase communications (Company A). Nonetheless, at Company D, it was perceived that the model should be presented to people only when it has enough information as to attract the interest of the model users, otherwise no appropriate feedback is received and conjectures about the final model usefulness are generated.

Using a phased implementation approach focusing on the local, project level, was identified as a further enabler (companies A, C and D). Having pilot implementations, i.e. model validity, also facilitates implementation success. Regular workshops to reinforce the need for the model and describe benefits accomplished are also beneficial. Flexibility on the way the model is used was identified as paramount to support model use.

IT has been perceived to provide further support as it could potentially help creating a routine, in which the process model could be used for the introduction of specific project information into the Company C’s intranet. However, the effectiveness of such approach cannot be assessed as this did not happen.

In terms of organisational support, having well structured project teams with roles and responsibilities clearly defined was a further enabler. Also, allowing people enough time to think over the process by having some organisational slack was the final way in which the organisational context could enable implementation success as identified in the case study companies.
6.4.2 Measures of PDP model implementation stickiness

The case study results have clearly demonstrated that the design and implementation of process models is laborious, time consuming and burdened with different difficulties. Even though there is a clear recognition in the literature that difficulties or problems happen during the different stages of a PDP model implementation, no attempts have been made on identifying and classifying such difficulties. A useful perspective to understand difficulties is provided by the technology transfer literature, more specifically by the measures of technology transfer stickiness proposed by Szulanski (1999), see section 2.5.4.

Table 6.4 illustrates people-based and knowledge-based failures that negatively affected implementation using Szulanski’s categories as a framework. The table also presents examples of stickiness factors identified in the case studies, drawing from the implementation restrainers described in Table 4.1 (Company A), Table 4.4 (Company B), Table 4.6 (Company C), and Table 5.3 (Company D).

<table>
<thead>
<tr>
<th>STICKINESS FACTORS</th>
<th>EXAMPLES FROM CASE STUDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PEOPLE-BASED FAILURES</strong></td>
<td></td>
</tr>
<tr>
<td>Arduous relationship</td>
<td></td>
</tr>
</tbody>
</table>
| Regards the ease of communications between process model developers and users. Barriers to transferring tacit knowledge reflect barriers to interpersonal communications | • not considering people’ expectations (A), and keeping expectations balanced (C)  
• poor communication, difficulties in sharing information (C, D)  
• poor involvement of user in model design (D) |
| Model designer lacks motivation           |                                                                             |
| Lack of motivation of the model developers in transferring knowledge to model users | • people see no reason to change methods of work (A)  
• lack of agreement of model aims by top managers leading to lack of motivation to design the model (D) |
| Model user lacks motivation               |                                                                             |
| Model users could also lack motivation, as implementation disrupt their normal activities as the process is being modified | • not perceiving or clearly demonstrating benefits on using the process model (A, B, C, D)  
• not invented here (A, C)  
• using the model as a ‘cool book’ not thinking over the process and people solving problems their own way (A, C)  
• perception of loss of power (B, D)  
• lack of agreement on design manager’s role (D) |
## STICKINESS FACTORS

### EXAMPLES FROM CASE STUDIES

#### PEOPLE-BASED FAILURES (continued)

**Model user lacks absorptive capacity**

The ability of the model users to identify, value and apply new knowledge, which is largely a function of the organisation’s prior related knowledge

- lack of knowledge / competence / poor understanding of the process (A, D)
- difficulties in understanding other stakeholders activities and constraints (A)
- different languages generating difficulties in achieving a similar understanding (C, D), and abstract language allowing for conflicting interpretations (A, D)
- lack of capability to manage design (D)
- lack of skills to implement (D)

**Barren organisational context**

The degree to which the organisational context supports the transfers

- not considering organisational change needed, the need for a new working environment (A)
- senior mgmt not understanding model’s value (A)
- middle management not involved (B)
- mandatory process (A, C)
- not providing enough training (A, D)
- business changes and process variability requiring constant redesign (A, B, D)
- confrontation between partners/business units (C, D)
- considers only one business unit (building) (D)
- divergent individual and corporate interests (D)
- divergent preconceived managerial ideas throughout the company (D)

#### KNOWLEDGE-BASED FAILURES

**Causal ambiguity**

Generated due to the complexity or depth of the practice to be implemented. The more complex a process model content is, the more likely problems will arise due to difficulties in adapting it

- excessively detailed model (A, D)
- poor definition of the design process boundaries (D)
- lack of clarity on key principles (D)
- difficult to update the model (D)
- difficult to adapt model to context: not applicable (D)
- did not consider how to adapt the model (D)

**Unproven knowledge**

Relates to the degree of conjecture on the utility of the process model. If the knowledge embedded in a process model is not considered robust, it can be assumed that it is likely that users wont apply it

- prescriptive model (A, D)
- usefulness at individual level not considered (A, B, D)
- model not piloted (B, D)
- difficult to get buy-in (B, D)
- convincing people that the process model works (C)
- excessive focus on control (D)
- information elementary to some (D)
- model perceived as a way to monitor people (D)

**Source not perceived as reliable**

The degree to which the model user perceives the model developer and the information used to build the model as reliable

- not considering cultural differences between companies (B, C, D)
- information used to design the model not credible (D)
- model designer not perceived as reliable (D)

Szulanski’s measures of stickiness were organised into people-based failures and knowledge-based failures. People-based failures are those related to difficulties in human relationships, lack of motivation, lack of absorptive capacity and the organisational context, as it influences peoples’ motivation and engagement with implementation. Knowledge-based failures relate to the content of the PDP model being
implemented, and include excessive model complexity, perception of utility of the model content and the reliability of the source of information used to build the model. Evidence has been found throughout the case study companies for the occurrence of all stickiness factors proposed, which validates the suitability of these measures to classify implementation difficulties. However, it is important to note that different companies experienced different difficulties at different stages of the model design and implementation.

Barriers on communications, difficulties in sharing information and poor consideration of people’s expectations represented arduous relationship at the case studies. These indicated difficulties in transferring tacit and explicit knowledge between model designer and users. The poor involvement of users during model design also contributed to an arduous relationship as inter-personal links could not be properly build.

Lack of motivation was a very important implementation difficulty at all the case study companies, especially in terms of the model users, as problems of motivation of the model designers were not very much emphasised. Even though, at Company D, the lack of agreement on the model aims throughout the company generated a number of changes during the model design, which lowered the motivation of the model designer as it made him question if the model would ever be appropriate to all and, therefore, if it would ever be implemented.

In terms of the motivation of model users, not clearly demonstrating or not perceiving benefits on adopting the process model was a factor that has been evidenced at all companies as lowering motivation. At Company D, this factor actually generated rejection and therefore blocked pilot implementation. The perception of loss of bargaining power as a consequence of the model use, linked with a lack of agreement on the role of the design manager have narrowed motivation levels at the case study companies. Finally, lack of ownership on the model, and the perception that other users did not consider the model and kept managing the process accordingly to rules that have previously worked in the past also diminished motivation.

The inappropriate ability of users to exploit the process model content has also been identified at the case study companies as negatively affecting implementation. Issues related to lack of design management knowledge, poor understanding about the design
process and lack of capability of design managers were identified at both companies A and D. As design managers did not have the necessary skills to manage the process, they also presented difficulties in understanding the knowledge described as part of the process model, and therefore in valuing it and applying it to improve management. Also, different languages are used to refer to similar activities throughout the company and between different stakeholders at companies C and D. This generated difficulties for users in exploiting the knowledge content of the model due to difficulties in understanding it. Also, as described in section 2.3, the challenges of abandoning old ways of doing things and preserving new ones were significant in the case studies.

The final people-based failure represents the degree to which the organisational context supports implementation. Constant business changes were identified at companies A, B and D as a problem, as they generate the need for constant re-design of the model. This, in turn, was perceived as a difficulty as the effort needed for the model re-design and for training could be great. At Company A, the negative influence of not achieving support from senior management, which helps in the creation of an appropriate organisational context for implementation, was greatly emphasised. In this sense, if senior management does not appreciate the value that the model brings to the company, and if they do not consider the need for organisational change in terms of a new working environment, implementation can be hampered. Appropriate support from senior management was essential in helping maintaining middle managers involved with and supportive to implementation, and it helped avoiding confrontation between business units with regards to the model and its use companies A, C and D.

The model being mandatory at the company was perceived as generating a negative context for implementation, as at one hand it caused resistance to change, and at the other hand it was hindering creativity by taking the ability of people in determining the more suitable way of managing each project. An important implementation barrier at Company D was the existence of divergent individual and corporate interests. At this case study, the model was being perceived as supporting corporate interests to the expense of individual interests (in terms of excessive control over individual activities). As the individual user is ultimately responsible for implementation, this conflict stopped him from using the model. A barren organisational context was also identified in Company D due to the model being developed considering only one business unit due to internal political issues, and the inappropriate consideration of the skills and
resources needed for implementation (i.e. involving the least possible number of people with implementation activities to reduce costs).

The knowledge-based factors leading to implementation failures identified in the case study companies relate to the complexity of the process model, the degree of conjectures over the utility of the model, and the source of information not being perceived as reliable.

The level of complexity of the process model content generated difficulties during implementation at companies A, B, and D (see sections 4.2.7, 4.3.7 and 5.2.7). The more complex or detailed the process model content is, the more difficult its adaptation both at companies A and D. This supports the research assumption described in section 2.5.4. Causal ambiguity generated uncertainty to proceed with implementation at Company D, mainly due to: (a) lack of clarity on key improvement principles, which generated difficulties in understanding the model content and role at the company; (b) poor definition of the design process boundaries, which generated difficulties during the model design and disputes thereafter; (c) non existence of any guides on how the model should be adapted or applied at the project context; and, (d) difficulties in updating the model due to its complexity level.

The importance and effects of not appropriately considering the utility of the process model at the company level has already been discussed at section 6.2.3. Nevertheless, it is important to stress once more that the fact that the utility of the process model was considered only at the organisational level and not at the project level was a major implementation barrier at companies A, B and D.

Finally, the degree to which the users perceive the model developers and the sources of information used to design the model as reliable also generated difficulties during implementation at companies B, C and D. At these companies, the main problem identified was related to not considering cultural differences between different business units and/or different companies that would be involved with implementation. The fact that such differences were not considered generated conjectures about the model reliability by users who were not directly involved in the model design. At Company D, both the information used to design the model and the person directly responsible for the model design were considered not reliable (see section 5.2.7).
In summary, the measures of stickiness have been proposed to provide a constructive way of considering difficulties in the analysis of PDP models’ implementation. By distinguishing between people-based and knowledge-based difficulties, one way to examine difficulties related to the most important aspects of implementation is provided. The next section discusses if case study findings supports or refute the two final hypotheses proposed, which relate to knowledge transfer in implementation.

6.4.3 Hypothesis 5: Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy

The analysis of the data from both exploratory and main case studies provides support for hypothesis 5. At Company A, the factors that affect the transmission, absorption and use of the process model were adequately identified and managed as part of an explicit implementation strategy throughout the years, and implementation showed a high rate of effectiveness. Conversely, at the construction companies involved in this study, such factors were not explicitly described nor managed as part of the implementation strategy, and the models were not successfully implemented.

In Company A, the team was responsible for keeping implementation strategy updated by identifying factors affecting implementation and acting upon them. Strategies to avoid the occurrence of restrainers were put in place, and great emphasis was given to constantly stimulate the factors enabling implementation (see section 4.2.8).

At Company B, factors affecting implementation were intuitively identified, but were not explicitly available through any documents. Different difficulties were known, but no strategies to avoid or reduce their effects were defined (see section 4.3.8). Similarly, at Company D, factors affecting implementation were intuitively identified, but these were not readily available (see section 5.2.8). It is likely that no strategy to reduce the negative effects of implementation barriers or to expand the beneficial influence of enablers was included at the implementation plans due to the lack of explicit availability of such information at both cases. Finally, Company C did not provide enough information to either support or refute this hypothesis (see section 4.4.8).
In summary, it is correct to state that efforts to implement process models in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of the implementation strategy will show higher rates of effectiveness than efforts in which those factors are not appropriately considered.

**6.4.4 Hypothesis 6: Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects that companies in which generic model is not continuously and explicitly updated**

Hypothesis 6 relates to the replication of the knowledge embedded in the PDP model throughout different projects, i.e. the routinization of the process model within the company. To support or refute such a hypothesis, information on successful implementation cases is needed. From the empirical data collected at the four case study companies involved in this research, only Company A provided a successful implementation case. At Company A, the generic PDP model was updated continuously and explicitly to capture specific experiences in its application (see section 4.2.8). However, this is an out-of-industry case. As none of the construction companies have successfully used their process models, it is therefore not possible to refute or support research hypothesis 6.

**6.5 Summary**

This chapter has discussed the cross case analysis for this research. First, the chapter discussed the main implementation triggers. Second, the implementation process at the case study companies was broadly described, and considerations on the lack of integration between the model design and its implementation in practice were reviewed.

Finally, issues on the implementation content were discussed. The implementation drivers and enablers identified at the case study companies were described through a typology that emerged from the data analysis. Factors restraining implementation were presented as measures of implementation stickiness.

The following chapter describes the main conclusions of this research and present suggestions for future work.
7 Conclusions

7.1 Introduction

The aim of this chapter is to provide a summary of the findings of this research. A summary of the key results are set out for each research hypothesis. The insights gained concerning the overall research problem are presented. Recommendations are given to increase the effectiveness of future implementations of PDP models in construction firms. Finally, suggestions for future research are presented.

7.2 Conclusions about research hypotheses

7.2.1 Hypothesis 1: Efforts to implement process models in which the model is considered to be applicable and useful by its users will present higher effectiveness than efforts in which the model is considered to be inapplicable or not useful

Core issues: model applicability and usefulness

The research literature advocates criteria to evaluate PDP models (see section 2.2.5). However, these criteria are fragmented and tend not to be classified in a way that provides a holistic and meaningful evaluation of PDP models with a view to their successful implementation (see section 2.3.1). The scarce literature that addresses process models evaluation provided support for hypothesis 1, as it describes model applicability and usefulness as features that support successful implementation. The findings demonstrated that an out-of-industry company in which the PDP model was considered applicable and useful had high implementation effectiveness. In contrast, construction companies in which the model had shortcomings on either applicability or usefulness resulted in unsuccessful implementation outcomes (see section 6.2.4). Therefore, the research findings provide support for hypothesis 1.

PDP model usefulness, or importance at the company level, is directly related to demonstrable benefits. This is the focus of hypothesis 2.

7.2.2 Hypothesis 2: Efforts to implement process models in which the improvements achieved in the PDP are clearly measured will present higher implementation effectiveness than efforts in which
there are difficulties in measuring the benefits resulting from the process model use

Core issues: clearly measuring benefits

The literature has consistently highlighted the importance of demonstrable benefits from change activities in general and, specifically, from the use of process models (see sections 2.3.1 and 2.4.7). This importance has been described both in terms of motivating users and in justifying the time and resources invested into PDP model design and implementation activities. The findings did not provide enough evidence to support or refute this hypothesis, as all companies defined performance measures (and stressed their importance), but only the out-of-industry case attempted to measure benefits from the model use. The construction companies did not attempt to measure benefits due to a number of difficulties (see section 6.2.5). Therefore, the influence of measuring benefits on the success of implementation is not demonstrable through the results.

The findings, however, provide indicative evidence that does not support the hypothesis; that is, the out-of-industry case showed difficulties in measuring benefits, but its implementation was still successful (see section 6.2.5). The company had endeavoured to measure the PDP at the initial stages of the model application, but the use of the measures was later abandoned (see section 4.2.5). Even though, not measuring benefits did not appear to have had negative influences over the success of the model implementation. It might be argued that this happened because measures were used when they were most needed, i.e. at initial implementation, as a means to support ‘unfreezing’ the current state. By contrast, when comparing these findings with advice on continuous improvement, it is evident that lack of demonstrable benefits is contradictory to ongoing success. Measuring performance is a basic requirement for consistent and continuous process improvement.

It has been argued that a degree of adaptation is necessary to allow a generic model to be effectively adopted at the project context and used to guide action (see sections 2.3.1 and 2.4.6). This proposition has been tested through hypothesis 3.
7.2.3 Hypothesis 3: Efforts to implement processes in which the generic process model is adapted into a project specific model and adopted in the project context to guide actions of the project team will show a higher rate of effectiveness than efforts in which such adaptation does not occur

Core issues: model adaptation and adoption

The process management and organisational change literature only superficially address the need for a generic model to be adapted and adopted at the project context in order to ensure its successful implementation (see section 2.3). The rationale behind the adaptation need is related to the one-off characteristics of product development projects. Adaptation also facilitates ‘unfreezing’ current state and behaviour, and ‘moving’ to the new state (see section 2.4.7). Results from the out-of-industry case, where the generic model has been adapted (through the design of business unit specific models) showed successful implementation as opposed to unsuccessful outcomes identified in the cases in which the models were not adequately adapted (see section 6.3.3). Therefore, support is provided for the hypothesis by the empirical data, demonstrating an important gap in the literature.

The adaptation that occurred in the out-of-industry company was largely enabled by the involvement of model users from different business areas with the design of the PDP model. Hypothesis 4 concentrates on the importance of considering individual needs and motivation to reduce resistance and encourage appropriate behaviour change (see section 2.4.7).

7.2.4 Hypothesis 4: Construction companies in which the generic process model is developed in full collaboration with motivated model users will show a higher rate of effective PDP implementation and replication when compared to companies where future users do not participate in the model development

Core issues: collaboration and motivation

The improvement of the PDP through the implementation of new working practices (described in a process model) is significantly dependent on the adoption of new patterns of appropriate employee behaviour (see section 2.4.3). Changing behaviour is often supported by the development of new skills, which is grounded in how people
learn. The literature is conspicuous to emphasise that motivation is essential to reduce resistance to change and support positive learning cycles. Learning is a process of gaining or changing insight, expectations and patterns: collaboration in strategy formulation and in model design is seen as means to increase motivation and buy-in. Research findings substantially support these arguments (see sections 4.2.6, 4.3.6, 4.4.6 and 5.2.6) The out-of-industry case in which the model was developed in collaboration with motivated users, implementation was effective, and where the models were designed without the benefit of deep collaboration, the opposite occurred (see section 6.3.4). Learning has also been affected by the way knowledge is transferred from the model developers to users, and different factors influence the effectiveness of knowledge transmission, absorption and use. Hypothesis 5 postulates that the appropriate and explicit management of such factors is beneficial to implementation.

7.2.5 Hypothesis 5: Efforts to implement processes in which the factors that affect transmission, absorption and use of the process model are adequately identified and managed as part of an explicit implementation strategy will show higher rates of effectiveness than efforts in which those factors are not considered as part of the overall implementation strategy

Core issues: factors affecting transmission, absorption and use of the model

If the new knowledge embedded in a model and generated through its design is appropriately transferred, interpreted and absorbed by users, it will support learning and enable implementation. It has been acknowledged in the literature that myriad factors contribute or hinder the effective transmission, absorption and use of the knowledge embedded in process models in real life settings (see section 2.5.5). The findings demonstrated that in the case studies construction companies intuitively identified such factors (see section 6.4.3). However, these were not explicitly addressed or managed during implementation. Findings also suggest that at the out-of-industry case, the factors were adequately identified and managed as part of an explicit strategy through more than 10 years. This has supported the continuity of implementation, and has provided the company with information that helped to redirect the model (re)design and use when needed. Therefore, the findings support hypothesis 5, as efforts in which the factors were appropriately identified and managed presented higher implementation effectiveness than efforts in which such factors were not explicitly considered.
The factors that contribute to the transmission, absorption and use of PDP models, identified in this research, were grouped according to the following typology: (a) effective **communications** in terms of providing appropriate exchanges of tacit and explicit knowledge; (b) appropriate **implementation strategy** formulation and execution in terms of considering the need for participation in model design and support for proper knowledge transmission; (c) **information technology** to enable the model use as the means to make knowledge available and support the suitable transfer of explicit knowledge; (d) **people issues** in terms of supporting buy-in, motivation, commitment leadership and training for the transfer and absorption of the model content; and finally (e) the influences from **the organisational and project context** in terms of creating the right environment for transfers of knowledge.

Difficulties on the transmission and absorption of the PDP model content were classified accordingly to the measures of stickiness (see section 6.4.2), that have been broadly subdivided into people based failures (i.e. **communications difficulties**, **lack of motivation**, **lack of absorptive capacity** and **barren organisational context**) and knowledge based failures (**causal ambiguity**, **unproven knowledge** and **sources of information not perceived as reliable**).

The findings also made it clear that drivers and enablers are closely related to the measures of implementation stickiness, i.e. the inexistence of an enabler generally generates a difficulty or implementation stickiness. A further issue that has been demonstrated at the successful out-of-industry case is the importance of continuously updating the model and its implementation strategy, which is the focus of hypothesis 6.

### 7.2.6 Hypothesis 6: Construction companies in which the generic process model is updated continuously and explicitly to capture specific experiences in its application will show higher effectiveness in replicating the model to different projects than companies in which generic model is not continuously and explicitly updated

Core issues: continuously updating the model

The importance of updating the PDP model knowledge content based on specific and ongoing experiences of its application has been widely discussed in the literature. Hypothesis 6 postulates that replication will be more effective in companies in which
such updating occurs since it demonstrates the model is valid, helpful, and important within the organisational context (see section 2.4.7). As stated in section 6.4.4, information on successful implementation cases is needed to test this hypothesis. The empirical data collected throughout the construction case studies do not provide such information, and therefore it is not possible to support or refute the hypothesis.

7.3 Conclusions about the research problem

The starting point of this study, based on the research problem set out on section 1.2, was that although there is a considerable body of knowledge on process modelling, and a number of models describing improved PDP management have been proposed, the espoused benefits of such models are generally not achieved in practice in construction due to inadequate consideration of implementation at the design stage and beyond.

The findings of this research validated this concern from different and complementary perspectives (i.e. the implementation triggers, process, content and outcomes), and have identified key problem areas. PDP models have been developed within construction companies aiming to achieve some of the espoused benefits of using such models in practice (see section 6.2). However, the implementation strategies of these models are superficial and only considered after the model has already been designed. This ‘bolt-on’ approach has lead to a number of problems. Figure 7.1 presents an adaptation of the theoretical framework of this research, presented in chapter 2 (Figure 2.8), which highlights the research hypotheses (see section 7.2). Findings describing the main implementation problems are summarised as follows:

- the implementation strategy formulation is not appropriately considered at the design phase of PDP models. Both the literature (see section 2.2.3) and the case study companies (see section 6.3) seem to have had an excessive focus on the model design, and insufficient attention is given to their use. This skewing of emphasis resulted in clearly structured models, which do not consider the strategy required to ensure their successful implementation. In particular, soft human issues, such as resistance to change, are not considered. In the construction case studies, the strategy has been set out too late in the process (only after the PDP model design), and it did not take into consideration the project level and individual needs;
• in the construction companies, inappropriate attention appears to be given to collaboration and motivation between the model designers and users (see section 6.3.2), which has been obstructing the transfer of knowledge between them. PDP models tend to be developed by a small team in isolation, focusing on discrete parts of the organisation as opposed to its whole. Even though feedback from some users is normally sought, this is done in a fragmented and ad hoc manner and users do not appear to have sufficient power to change the model. As a result, users are not engaged, and the motivation levels for implementation are low. Therefore, the need for commitment and collaboration during model design needs to be highlighted;

• a number of improvements for current practice are proposed in the generic PDP models devised within the case study companies (see section 6.2.2). However, the role of the models as control tools appears to have prevented such improvements being realised in practice (see discussion below, section 7.3.1). Also, the models analysed presented shortcomings both in terms of their applicability and usefulness at the project level (section 6.2.3). As a consequence, these models were not adapted to guide the project team;
implementation drivers, enablers and restrainers were identified at each of the stages of the implementation process i.e. the strategy definition (triggers), the design and resulting PDP model content (content); the adaptation of the model at the project level and its adoption to guide actions of the project team (implementation process) (see sections 6.4.1 and 6.4.2); It was initially expected that factors would affect implementation mainly through the model adaptation at the project context (i.e. implementation process). Nevertheless, this was not the case, and the importance of factors related to the strategy definition, as well as to the content of the process model itself became explicit throughout the research findings;

• findings from the out-of-industry case indicated that analysis, feedback constant update and redesign of the process model are essential for its successful use throughout the years (section 6.4.3 and 7.2.6). In this way, it is considered essential to promote the consideration of measurable benefits and the constant update of the model accordingly to its use through time as means to support continuous implementation and improvement.

In summary, the implementation process in the construction case study companies were, in general, poorly defined and managed. The poor consideration of what was needed for successful uptake of the model in terms of the implementation strategy formulation coupled with the lack of the meaningful participation of the people involved with implementation were major issues identified. Also, inappropriate consideration of the links between the changes needed at the organisational, group and project levels was identified, with a particular lack of consideration of the individual level (i.e. benefits of change for the organisation were generally determined, but these were not available for the individual, model users level).

Also, the need to transfer the process model content from model developers to users had not been considered within the construction case studies. In one case, it was believed that publishing the model would be sufficient to allow for its absorption and application. There was also a somewhat positivistic approach in which it was believed that the models would be adopted if mandated throughout the companies.

The next section presents a discussion on the role of process models and the influence it has had on implementation success.
7.3.1 Discussion on the role of process models

The rationale for generic PDP models has developed under a traditional project management control perspective, which considers that work should be planned completely before starting (see section 2.2.1). This somewhat prescriptive perspective emphasises that management should foresee the future state of the process (i.e. goal definition), perform centralised planning to articulate steps needed to take current state to ‘goal’ state, and control is exercised by monitoring progress against plan and defining corrective action needed to keep to plan. Indeed, the literature has greatly emphasised that a PDP model should provide managerial tools to increase control and, in this way, support decision-making and consistency (see section 2.2.3). Accordingly, process models are tools to support the articulation of centralised planning (by defining activities and deliverables, the model should be used as a basis for planning), and control is exercised by monitoring and taking corrective action when necessary (e.g. phase reviews are monitoring milestones).

However, the low level of success in process models’ implementation brings the validity of this overall approach into serious question. Findings from this research stress that process models have failed to provide product development ‘centralised planning and monitoring’ within construction (see section 6.3). Also, a misinterpretation occurred in which the model was understood as being a tool to control people as opposed to improving the process (see section 5.2). This is a major barrier, as it generates widespread cultural concerns with regards to the company objectives in impinging the process model use.

Also, the out-of-industry case indicated that implementation could only be successful when a ‘softer’ approach to the model use was taken. Model usefulness was closely related to the role of the model, which was approached as a learning framework providing room for reflection and innovation by autonomous stakeholders, as opposed to impinging control over individual activities (see section 4.2). However, appropriate control and formality is set in the process through the adoption of phase reviews. In this way, it is postulated that descriptive approaches to formulating and executing implementation focusing at enabling learning at the locus of implementation (i.e. project level) support the achievement of more successful outcomes.
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7.4 Recommendations to increase the effectiveness of future PDP model implementation

7.4.1 Introduction

In simple terms, the findings of this study demonstrated that the design and implementation of process models is very complex and, consequently, there are a number of difficulties associated with it. Minzberg and Waters’ (1985) work on the intended and realised strategies helps understanding the basis of the implementation problems in practice, and at the same time offers a theoretical insight into an appropriate PDP models’ implementation strategy.

The benefits that a PDP model can generate can only be achieved and enhanced if the model is linked to an appropriate strategy for implementation, which provides the overall driving force for individual actions. The relationships between the strategy and individual actions are represented in Figure 7.2. The figure describes the intended strategy as an initial idea providing an overall direction (‘implementation strategy’ in Figure 7.1, comprising plans defined in the beginning of the process). Some of the intended strategy is unrealisable in the light of events, and generates the unrealised strategy. This leads to the deliberate strategy, which is adapted or redirected by emergent ideas (individual actions), resulting finally in the realised strategy. The realised strategy is different from the intended strategy, but the overall direction has still been determined by the intended strategy.

Figure 7.2: Deliberate and emergent strategies, from Minzberg and Waters (1985)
The research results showed that the intended strategy is defined at the organisational level, generally by high managerial levels. As the PDP models should be used within projects, the emergent strategy materialises at the project level through individual actions. Emergent and intended strategies may diverge due to conflicting interests (and opposing perceived benefits) between the organisational and project levels. Such conflicting interests were very much shaped by the excess focus at the organisational level in using the PDP model as means to ‘command and control’ product development. Therefore, the emergent strategy developed into a blocker to implementation, as illustrated at Figure 7.3. Intended strategy and emergent strategy engaged in a mutual process of degradation and ‘grid lock’ until the PDP model falls either into disuse or within fragmented, inconsistent pockets of ‘specific’ product development processes.

![Figure 7.3: Emergent strategies as implementation blockers](image-url)

The strength of the emergent strategy in acting as a complete blocker of implementation as opposed to being only an element which slightly changes the overall direction of the intended strategy (as proposed by Minzberg and Waters, 1985), also takes place due to the nature of construction projects. In construction each project produces a unique product and has a specific structure and links between the stakeholders on the supply chain. Accordingly, relationships are typified by short term interactions between independent businesses (Gann, 1996), and organisational arrangements in terms of responsibility and authority put emphasis on the efficiency of individual projects.
Also, great levels of complexity related to uncertainty and interdependence among tasks make it difficult to apply a centralised approach to decision-making, and the nature of the interdependencies seems to favour local (project level) rather than centralised (organisational level) coordination (Dubois and Gadde, 2002). Due to these characteristics, there are tight couplings on individual projects combined with loose couplings at the organisational level, and these are necessary to make it possible to cope with uncertainty and interdependency (Dubois and Gadde, 2002). The inappropriate consideration of such tight project level couplings in the implementation strategy formulation is a main implementation block. By having such tight couplings, each construction project has strategies of its own, and these need to be considered at and aligned with the overall implementation strategy.

Therefore, it is here argued that for the successful implementation of PDP models in construction, there is a need for the overall implementation strategy to be considered from a bottom-up approach, placing the appropriate importance to the decisive role of the emergent (project level) strategy. Such bottom-up approach enables the emergent and intended strategies to be aligned towards a similar direction, moving from a disjointed (Figure 7.4 A) to an integrated approach (Figure 7.4 B). This requires a more flexible and holistic approach to manage the dynamic aspects of implementation.

Figure 7.4: proposed focus for implementation at the project level through emergent strategies
Hence, key recommendations to manage difficulties and increase the effectiveness of future PDP models implementation focus on a broader, systemic and flexible framework for the design and implementation of PDP models. Such framework has been derived as a result of testing the hypothesis as well as on the main issues identified in the literature. However, the issues identified in the hypothesis are addressed in the recommendations, but not listed, and are presented as follows.

7.4.2 Systemic and flexible framework for the design and implementation of PDP models

Key recommendations on implementation have been based on the need to consider implementation from the perspective of aligning the emergent project level strategy to an intended organisational strategy implementation direction. In summary, the approach advocates that the design and implementation of PDP models are considered jointly, in a flexible and holistic manner that align organisational and project levels, and with a focus on meaningful participation and dynamic problem solving as means to achieve successful outcomes. The key principles of the framework are posed as follows.

1. Global strategy, local activity

The design and implementation of PDP models need to adopt an approach that aligns both the overall directions formulated at the organisational level and the emergent strategy at the project level. Two main issues are necessary to allow such synergy to occur. First, a ‘bottom-up’ approach needs to be set for the implementation strategy formulation, emphasising a continuous driving force for implementation; Second, organisational level strategy needs to be set in a flexible and adaptable manner, so that it provides an integrating general direction for implementation.

It is also argued that the overall implementation strategy formulation should hold the commonalities between the views and interests of the different stakeholders involved with implementation at both levels. Therefore, a soft global outlook (at the organisational level) can be combined with hard local responsiveness (at the project level) in a way which is supportive of successful implementation.
2. Symbiotic model design and implementation

The design and implementation of PDP models need to be considered jointly to allow successful implementation outcomes to be achieved. Considering design and implementation in a symbiotic way makes explicit a number of issues. Firstly, it makes clear the need to appropriately debate and reach consensus about the role of the model within the company and its configuration, while at the same time considering the model adaptation and use in each project. Second, it makes evident the need to focus on the entire company as opposed to one specific unit. In a similar way, focusing on discrete parts of the process as opposed to its whole is avoided. The use of diverse strategies to transfer the PDP knowledge from the model designers to users is enforced, and both hard (paper) and soft (seminars, workshops, focus groups, etc.) approaches to transferring knowledge are required.

Finally, instituting senior group meetings as an ‘implementation committee’ on a regular basis can help ensure continued implementation over the longer term. Therefore, the approach used to manage the model design and implementation will be evolutionary and dynamic in nature.

3. Learning rather than managerial ‘command and control’ focus

PDP models need to be approached in practice as overall frameworks to allow learning and commitment, as opposed to means of introducing hard controls over detailed process activities. Current literature emphasises the role of process models as hard control mechanisms (see sections 2.2.3 and 2.2.5), but such an approach has proven ineffective in practice by the case study results (see sections 2.2.3, 2.2.5 and 6.2.3). Industry level process models are useful in terms of establishing high-level process stages and improvement principles that could be incorporated in company specific process models, and subsequently adopted in practice. However, both industry level and company process models will not be used if they prescribe detailed levels of activities and if the underlying philosophy is to introduce hard controls in the process.

In effect, an appropriate level of control should be sought through the model, allowing efficiency and reliability of stable activities to be achieved but, at the same time, the project level (model users) need to retain the capability to identify situations which require change, ensuring effectiveness and responsiveness throughout the process. This supports process innovation and improvement allowing for the autonomy of
management at each project. It also allows the ‘design’ of the best possible way of managing the process by considering good practices and also the structure of physical, political and cultural settings of product development action at each project context.

4. **Meaningful participation and collaboration**

Successful PDP model implementation requires appropriate participation and engagement. Therefore, focus should be given to participatory decision making during the model design rather than the usual decoupling of teams developing and implementing the model. This would encourage the symbiotic model design and implementation advocated earlier. Participatory decision making also entails providing equal power or influence between model developers and users so that users’ views can be integrated during the model design. Meaningful participation and collaboration allow transfers of both tacit and explicit knowledge and help generating the necessary capacity to adapt the model to the project context.

However, the design of a process model is a difficult endeavour, and involving a large number of people can make it a very complex task, creating difficulties in achieving the expected results. Therefore, such participation needs to be sought through an appropriate balance between direct involvement in the model design and focused feedback during the drafting of the model. The attainment of meaningful participation and collaboration can be stimulated and leveraged through the adoption of varying mechanisms for creating and sustaining motivation and commitment.

5. **Relevant and holistic PDP model content**

A PDP model needs to be relevant, i.e. useful and applicable to allow its successful uptake. Even though this appears to be common sense, research findings revealed that this has not been the case at the construction case study companies. The proposed criteria to evaluate process models’ content (see section 4.2.3) provide a framework emphasising the need for flexibility, ease of use, credibility, validity and measurability for the successful implementation of a PDP model.

Emphasis on the model content should be given to a generic level; therefore time and efforts are not wasted in designing detailed levels of activities which, in reality, are highly variable. It is argued that consistency of efforts towards satisfying core business needs is essential, however consistency at how this is done at detailed levels is not
essential (Barrett, 1995). This enables the organisation to respond to specific project
needs using individual skills. Furthermore, it allows for the flexibility needed for
adaptation, supporting process innovation.

The PDP model content must also be focused in achieving benefits for both the
organisation (in terms of increased competitiveness and profits) and its clients, by
emphasising the value adding aspects of the PDP. The overall quality provided through
product development will be assessed from different perspectives (e.g. time, design
quality, exceeding client requirements, etc), and consequently construction companies
should place more emphasis on better capturing and translating clients requirements.
Finally, the model’ key process improvement principles should be transparent, and
means of adaptation to different project contexts need to be clearly described.

6. Implementation levers
Implementation levers were proposed based on a typology to classify factors driving,
enabling and restraining implementation. Conditions to avoid restrainers and support
enablers were proposed and such implementation levers can be directly related to each
one of the five implementation recommendations previously described. Implementation
leavers (or factors leveraging implementation) are presented in Table 7.1 and described
as follows.

First, the PDP model needs to have one agreed meaning. To achieve this, the role of the
model within the company has to be discussed with model users. Emphasis should be
put into having a simple model, which transparently presents key improvement
principles. IT can be used to enable publishing the model, supporting the dissemination
of explicit knowledge. Second, the model needs to be explicitly useful and applicable,
and for that the knowledge embedded in it has to be robust.

Third, good relationships between model designers and users need to be encouraged and
nourished. Social interactions play an important role in it as they enable the transfer of
tacit knowledge. Fourth, model designers and users need to be motivated. Mechanisms
should be put in place to support behavioural changes in a way which is aligned with
the main driving force for implementation. Motivation is also essential in keeping
people interested and persistent to achieve successful implementation.
Table 7.1: Factors affecting implementation and proposed implementation levers

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Typology of factors affecting implementation</th>
<th>Implementation levers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant and holistic PDP model content</td>
<td>Causal ambiguity: generated due to the complexity or depth of the practice to be implemented</td>
<td>• Model having one agreed, consistent meaning (consistent model role)</td>
</tr>
<tr>
<td></td>
<td>IT enabling implementation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unproven knowledge: degree of conjecture on the model utility</td>
<td>• Explicitly useful and applicable model</td>
</tr>
<tr>
<td>Meaningful participation and collaboration</td>
<td>Arduous relationship: ease of communications between process model developers and users</td>
<td>• Easy communications</td>
</tr>
<tr>
<td></td>
<td>Source and recipient lacks motivation: lack of motivation of the model developers and users in transferring knowledge</td>
<td>• Motivate users and designers</td>
</tr>
<tr>
<td></td>
<td>Source not perceived as reliable: model user do not perceive the model developer and the information used to build the model as reliable</td>
<td>• Reliable source of information</td>
</tr>
<tr>
<td>People issues</td>
<td>Recipient lacks absorptive capacity: the ability of the users to apply new knowledge</td>
<td>• Learning focus</td>
</tr>
<tr>
<td>Learning rather than managerial ‘command and control’ focus</td>
<td>Implementation strategy (considering model design and use)</td>
<td>• Appropriate model design and implementation strategy</td>
</tr>
<tr>
<td>Synergistic model design and implementation strategy formulation</td>
<td>Barren organisational context: the degree to which the organisational context supports the transfers</td>
<td>• Bottom-up implementation strategy formulation</td>
</tr>
<tr>
<td>Synergistic implementation strategy alignment (align intended organisational directions and emergent project strategy)</td>
<td>Supportive organisational and project context</td>
<td>• Fruitful organisational and project context</td>
</tr>
</tbody>
</table>

Fifth, the sources of information used to design the model need to be trustworthy, so that the perceived reliability of the model in bringing process improvements is maintained. Sixth, as argued in section 7.3.1, the model and its implementation need to be approached from a ‘softer’, learning perspective, so that resistance to change is avoided and the necessary absorptive capacity is created.

Finally, and most importantly, the implementation strategy needs to align a flexible overall implementation direction at the organisational level with a responsive emergent project level strategy, while at the same time considering the design and implementation of the process model in an integrated, symbiotic way so that short learning cycles enabling successful implementation can be created.

7.5 Key limitations

In the course of this research a number of issues have not been addressed. This reflects the inevitable complexity and diversity of issues involved in the implementation of
Chapter 7: Conclusions

process models. The particular focus of this research is to improve the understanding of PDP models in construction firms, and the approach taken to do so has been clarified and supported in chapters 1 and 3.

There are a number of key limitations to this research. First, the case study approach used means that the results cannot be generalised beyond the sample set. However, the sampling strategy used in this research ensured that representative large contracting firms within the UK was chosen, and therefore the results can be applied with a degree of confidence to the wider population.

Second, the sample focused on large contractors, the investigation did not focus on other types of firms, for example small firms, or other industry sectors such as architectural or engineering practices. Third, the results did not provide enough evidence to support or refute both hypotheses 2 and 6, and, consequently, these are proposed as areas for further research (see below).

Finally, another restriction of the research is the fact that there were no identified successful cases in construction companies. However, it is believed that the findings from the unsuccessful cases provided sufficiently rich information to allow the proposition of recommendations for successful future implementations. The fact that the cases were unsuccessful made it possible to stress issues that might not have been identified through the analysis of successful cases.

7.6 Future research

The importance of further research on certain topics became evident throughout the analysis of the findings. The following areas for further research can be proposed from a perspective on generating empirical data on practical cases of implementation:

- survey of the number of construction companies in the UK aiming at implementing process models, and the identification of success rates of implementation within the industry as a whole;
- exploring the difficulties and influence that clearly measuring benefits from a process model use have on the implementation success (providing empirical evidence to test H2); and
• exploring what influence updating the model has over the success of implementation throughout time, and the importance of feedback from project specific implementation experiences (providing empirical evidence to test H6).

Examining the research area from a broader theoretical perspective, the following areas for further research can be posed:

• research into a broader definition of success, approaching both successful PDP model implementation and the commercial success of the company in terms of competitiveness and profit;
• most PDP models have been developed from a top-down approach, i.e. a generic model is developed on basis of key principles generally from previously developed models, and these should be adopted at the project level. Further research should focus on devising models based on good practices from project experiences and then generalising such models for further application, i.e. adopting a bottom up approach which generates theory from empirical data;
• studies exploring links between performance measurement and implementation of process models, i.e. how to measure benefits through a PDP model use. The applicability of approaches such as the balanced score card could be evaluated;
• if implementation is successful, what are the influences that personnel turnover can have over the sustained use of the model through time;
• the definition of appropriate and achievable role and benefits of PDP models require further studies. There is a need to link and appropriately balance ‘hard’ research into processes (focused on management from a control perspective) and soft research into commitment and learning (e.g. the approach proposed by Flores, 1982, see also Howell et al., 2004); and
• a further, interrelated issue that appears in the research findings to be surprisingly unclear and therefore requires further research is related to the role of construction companies in managing design, as part of the PDP. There is an apparent and urgent need for a better definition of what is the responsibility of a contractor in managing design and product development. This is especially important if one considers the current growth of D&B and PPPs, in which contractors are directly responsible for design development.
7.7 Final comments

Section 1.1 situated this research within the concern that great efforts have been put both in the academic community and in practice to the design and implementation of generic process models, more specifically PDP models. However, the proposed benefits of the models could not be accomplished in practice due to a number of problems in their implementation.

The focus of this study was to contribute to a better understanding of PDP model implementation in construction companies, so that the lessons learnt can feed back into better quality design and implementation of PDP models. It also endeavoured to reveal the reasons why the espoused benefits of process models are difficult to accomplish. The findings of this research have revealed that PDP models use is a very complex process that has been unsuccessful due to inappropriate consideration of implementation. As a consequence, companies cannot achieve the proposed benefits and the efforts and resources put into the model design are wasted as the models are left unused.

This research, however, has provided a detailed description of implementation cases, uncovered common implementation problems by analysing implementation through different theoretical lenses. It also provided evidence to help understanding the role of PDP models within construction companies, and offered a framework to evaluate the model content with a view to its implementation.

Finally, proposed recommendations deriving from both the literature and the main findings were presented. Such recommendations emphasise the need to align the intended organisational to the emergent project level implementation strategies, and consider the design and implementation of the process model in an integrated fashion as essential to allow successful future implementations.
References


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Appendices

Appendix A: Improvements proposed through process models

Definition of the process activities: the whole project view

A process model describing the activities, deliverables and functions involved in a project is necessary to allow the achievement of consistency and integration in the projects developed by a company (Cooper, 2001). Defining the activities of the design and construction process covering the whole life of the project from recognition of the need to the operation of the facility has been described as the ‘whole project view’ (Kagioglou et al., 1998). It can assist in achieving consistency as similar sub-processes and managerial principles can be applied to all stages of different projects. Also, it makes clear for stakeholders which part they play in the project as a whole, creating process visibility (Koskela, 2000; Ulrich and Eppinger, 2000).

The whole project view also makes it possible to hierarchically decompose the process, which allows for the definition and control of activities (Gray and Hughes, 2001).

The sequence of PDP activities

Many problems of the PDP have been related to the way the process activities are sequenced. Due to this factor, different improvements have been proposed focused on the way these activities are ordered. The main improvements relate to: (a) developing the process concurrently instead of in a sequential fashion aiming at reducing lead times and increasing quality; (b) reducing waiting for information through planning; and (c) reducing rework by specifying internal and external client/supplier relationships. The problems related to the traditional sequencing of the PDP are briefly presented to ground the discussion, followed by the improvements proposed.

The design and construction have been traditionally developed in a sequential approach (Prasad et al., 1998; Anumba and Evbuomwan, 1997). Accordingly, the process moves through different and isolated phases, as shown in Figure A.1. Normally, design activities are isolated between different design disciplines, and also from physical production, services and other functions (Syan, 1994). In the sequential approach, information is batched and passed on to the subsequent activity, until production is ready. This results in a process which is essentially linear with hard breaks between the phases of the process (Backhouse and Brookes, 1996).
The methods adopted in this model are functionally oriented with little integration, rather than process oriented (Yazdani and Holmes, 1999). Each function, such as marketing, engineering, and sales is expected to play a specific and limited role within each phase (Hayes et al., 1988). This model has not proved to be satisfactory to cope with the emerging industrial pressures, i.e. reduced cost and time and better quality (Prasad et al., 1998). Changes in this system are normally initiated in physical production, and those changes go back to the design stage. Depending on the nature of the change required, a number of design activities need to be repeated, and this has an important impact over the lead-time of product development (Syan, 1994; Yazdani and Holmes, 1999).

Concurrent Engineering (CE) emerged as a response to the drive to reduce development lead time and costs, and the consequent necessity of a greater involvement of downstream activities to bring all specific expertise into the design stage (Yazdani and Holmes, 1999). The concurrent model seeks to integrate functions to provide knowledge about product and process in the design stage, developing the product and manufacturing processes simultaneously and thus achieving reduced lead times (Prasad, 1997; Syan, 1994). There are usually gates attached to each stage. Information exchange is facilitated by the introduction of multi-functional teams (Yazdani and Holmes, 1999). Usually there is a matrix style organisation related to the concurrent model (Ulrich and Eppinger, 1995). The main difference between the sequential and concurrent models is depicted in Figure A.2.
Different authors present diverse CE principles with various emphases. Within the construction domain, authors such as Prasad (1996); Anumba and Evbuomwan (1997); and Kamara et al. (2000) presented CE principles, which can be summarised as: (a) reduction of lead times and costs; (b) quality improvement; (c) teamwork; (d) importance of the value aspect of design; (e) integration of physical production and product development; and (f) product life-cycle considerations.

However, companies can choose the most appropriate product development organisation for each project at hand. The level of complexity of the model adopted by each company will depend on myriad factors that affect the process, such as the market competitiveness, the complexity of the product being developed, the importance of faster product introduction, the level of uncertainty involved in the process, between others (Formoso et al., 2001).

The literature presents other means to reduce lead times in product development, apart from developing the design of the product and of the production system concurrently, and overlapping design stages. This relates to planning product development activities focusing on the information flows within the process. By defining the information needs for each activity, it is possible to re-order the sequencing of such activities, thus reducing interactions and enabling planning (see, for instance, Austin et al., 1994; Baldwin et al., 1999; Austin et al., 2000). One technique used to reorder design activities in the task level is the Dependency Structure Matrix analysis (DSM) (Eppinger, 1994). It represents in a matrix sequential, parallel or coupled tasks (i.e. mutually dependent tasks that need to be carried out in an iterative fashion, since each task require some outputs of other tasks in order to be completed).

By focusing on information flows it is possible to reduce waiting times for information transfer throughout the process (Houvila et al., 1997). It also allows the clear specification of the suppliers work in relation to its internal client (Ballard, 1999; Koskela, 2000). By specifying internal and external client needs, it is possible to reduce requirement changes and therefore reduce rework in the process caused by variability and uncertainty within the design tasks (Reinertsen, 1997).

Nonetheless, planning design activities is challenging. Due to the nature of the process, it is difficult to assess the amount of completed or remaining work in any design task and, consequently, in the project as a whole (Reinertsen, 1997). Furthermore, in the PDP work tends to expand to fill the available time, because it is always possible to improve design in some way (Reinertsen, 1997). As a result, it is not possible to plan the PDP as a sequence of well defined steps, since most decisions are affected by some that have been made before and also by others.
that will be made in the future states of the project. Thus, the usefulness DSM to plan design activities in practice since remains to be found (Koskela and Ballard, 1997).

**Phase reviews, or stage-gate approach**

A further improvement proposed in process models is the phase reviews, or stage-gate approach. The stage-gate approach has its routes in the phased project planning developed by NASA in the nineteen-sixties, which is described as the first generation process (Cooper, 1994). Cooper (1994) further developed this concept, through the second and third generation processes.

The second generation stage-gate process presents discrete stages preceded by review points or gates, which can vary in number depending on the organisation that is using it. Each stage represents a group of activities developed by multifunctional teams. The gates represent decision points in which the project is approved to continue being developed or is withdrawn (go/kill points). Therefore, they present criteria that a project should meet in order to proceed to the next development stage, serving as quality control checks, and are usually controlled by senior managers (Cooper, 1990).

Nonetheless, problems have been associated with this model, such as the impossibilities of overlapping stages, the fact that the projects needed to wait until all tasks were completed within each stage, excess of detail in some projects, and lack of focus (Cooper, 1994; O’Connor, 1994). To overcome these problems, Cooper (1994) presented the third generation process, illustrated in Figure A.3.

![Figure A.3: third generation stage-gate process, from Cooper (1994)](image)

The main characteristic of this model is the overlapping stages, in which go/kill decisions are delayed to allow more flexibility and speed, and the gates are presented as fuzzy gates, which can be either conditional or situational. Conditional gates are subject to a task being complete at a specified time in the future, and the information generated by the task being positive. Situational gates relates to a go decision being made when some tasks are not yet completed, but the information produced by those tasks is not vital for the project (Cooper 1994).
The application of the stage-gate concept to the construction industry has been proposed in the Process Protocol (Kagioglou et al., 1998). This model adopts a phase review process, which applies planning and review procedures in terms of ‘soft’ and ‘hard’ gates, similar to the conditional gates proposed by Cooper (1994). As pointed out by Kagioglou et al. (1998), the main benefit of the phase review is the progressive fixity of design decisions. This means that some design decisions should not be changed after being approved by senior manager or by the client within each of the phase reviews. Therefore, it allows for increased predictability in a project. Also, a consistent process within a company can be achieved through the consistent application of the phase reviews, together with the adoption of a standard approach to performance measurement to facilitate continuous improvement (Kagioglou et al., 1998).

A further benefit is that phase reviews facilitate a means by which project experiences can be recorded, updated and used, thereby informing later phases and future projects through feedback. This information can be stored manually or electronically through the concept of a legacy archive (Kagioglou et al., 1998).

**Teamwork and coordination between specialists**

The importance of teamwork and coordination is related to the need for defining stakeholders’ roles, defining when their contributions are needed and specifying information needs (Cooper and Press, 1995; Koskela et al., 1997; Kagioglou et al., 1998; Ulrich and Eppinger, 2000; Cooper, 2001), which should enable effective decision making throughout the project life cycle. The need of integrating functions and consulting participants early in the process to provide the necessary knowledge and avoid changes in later project stages has also been described (Syan, 1994; Prasad, 1997; Yazdany and Holmes, 1999; Gray and Hughes, 2001).

Further potential improvements have been proposed with regards to teamwork and coordination. First, the necessity to delegate a stakeholder the authority to co-ordinate the participants and activities of each phase has been described. This person should ensure the correct application of the high-level process to the project in hand (Kagioglou et al., 1998). Within product development, this stakeholder could be, for instance, a design manager.

The importance of empowering teams to make decisions therefore reducing the effort for information transfer (Koskela, 2000) has been also stressed. Empowerment gives the individual and the team the ability to manage at a local level both the work agenda and the immediate environment, which has the potential to improve quality of the work life, increase the potential problem-solving capability of the company and promote continuous improvement (Tranfield et al., 1998). Through teamwork and commonly held project goals the mutual consideration of all decisions and collaboration to resolve conflicts could be achieved (Koskela, 2000).
Use of IT solutions
Various technological solutions for collaboration, engineering databases, project intra and extranets, between others are increasingly more important in making product development activities more efficient and to improve communications between the parties involved (Soibelman and Caldas, 2000; March and Flanagan, 2000). Examples of such type of solutions are proposed in the Process Protocol, and can include electronic data interchange, artificial intelligence and document management systems. Therefore, technology can be used to enhance integration and information sharing. A process map should enable the effective use and coordination of technology based on a predetermined process framework (Cooper et al., 1998). It is important that for a stable process to be in place before the implementation of IT to avoid potential new sources of waste, such as non-compatibility of design tools that causes set up waste through manual data conversion (Aouad et al., 1998).

Increase the focus on the clients
The importance of focusing process activities to meeting clients’ needs and requirements to achieve better value through the PDP has been largely described in the literature (Lanthan, 1994, Egan, 1998; DTI, 2002). The need to better capture client requirements and to improve the communication of these requirements in construction at the earliest stages has also been described (CRISP, 2001).

Nonetheless, problems have been related to requirements capture. For instance, missing requirements can occur due to poor requirements analysis or specific features of the situation (Smith et al., 2001). Since the customer usually consists of a great number of people and the number of requirements may be large, their management gets cumbersome (Barrett and Stanley, 1999). Also, part of the requirements may be lost during design development (CRISP, 2001). For instance, part of the design intent is not communicated to later steps, and may be spoiled by decisions in these.

Different authors propose improvements to requirements capture that could be introduced through process models (such as Cooper and Press, 1995; Prasad, 1998; Hassan et al., 1999; Barrett and Stanley, 1999; Kamara et al., 2000; Smith et al., 2001). Examples of such solutions include increasing the involvement of end user by identifying, agreeing and recording requirements early in the project life cycle (CRISP, 2001). Also, tools such as Quality Function Deployment (QFD) which provides formal linkage between requirements and solutions (Zairi and Youssef, 1995; Prasad, 1998) could be used to support the client requirements capture process.
Appendix B: Example on an interview transcript

Transcription of the interview with Mr GL
Company D senior design manager and developer of the design management process model (all names have been excluded)
Date: 19 June 2002 Duration: 2:00h

Introductions…
We just have a little of caution about this – the material for the company – I don’t know what you are going to do with this but we don’t want it to end up in the hands of our competitors...

About the design and build guidance notes: I can tell you to what extent it has been taken up, and the answer is not at all, and the reason was proper launch for it, there was no programme to actually implement it, it was put our internet system and under quality assurance, so it was not a compulsory document, and we did actually gather all the design managers together that were working in different contracts and …this was written for the building area, and in that ... most of them couldn’t be bothered because they were too busy. That’s the history. This time is going to be different because of there is a proper programme and it is coming from the top of the company, a proper initiative to train and to follow up for this thing for a long period after that documentation has been put up.

The questions

1. What is your function in Company D?
I joined Company D five and a half years ago, and I’m an architect by background, and my job is primary to do bid management, for design and build tenders. It didn’t last very long before I found myself taken at a series and troubled complaints, which earlier on were got into people that were into the design management and I was after that there for 3 months and I ended there for 2 ½ years. After that I came back and worked on producing this process map, the first one, and I then went off to be the design manager on a new project, £35 million, commercial and residential project in (name of the city) I was there about a year, but it was a two stage tender, and we didn’t go as far as the second stage when the client decided our price was too high and then we lost the job. So after that I fount myself in a even worst troubleshooting situation, on a even worst contract, which have gone very badly overall, and this was at a late stage and we manage to … and see that it was not working for us and we finish the project and the design, and then we did it. And then we have to get that situation going again. And that’s taken me off until the last few of months, when I have been redrafting the process map and that should be done because it is disaster.
The company

2. Which is the procurement methods usually applied at Company D?
We do a lot of design and build. We have also been increasingly involved in the larger commissions, particularly all those PPPs… again are design and build, so it’s… and its popular with the clients because of the risk development, most of the risk goes to the contractor. In my point of view we have no choice, we have to do it to stay in the business, and we have to learn from it as well.

3. What is the average number of projects the company develops a year?
Do you know what is our turnover?… its difficult to say to you right now for construction, I don’t have those figures at hand but if you leave me a copy of that I can send this to you afterwards. I mean, in a point of time we have around 100 projects a year so the figure is around that, but that’s a guess.

4. In your view what’s the company strategy regarding NPD-design & construction?
Time is price. You know, every day you keep a building site running it costs you another 8,000 pounds, so you can’t distinguish between time and cost really. We have to compete on both time and cost, and it’s difficult to say if we focus on any one rather than the other. There is a straightforward equation between building contract time, building period and cost, buildings can be done quicker but it costs much more….
We don’t have any new products, we just go with the market really. That’s untruth, because the company’s stated policy now is to move a substantial proportion of our construction work into facilities management type of work, where we have a whole series of smaller construction projects to do…

5. Which features you believe make the company good at projects?
The only new product development I might think of is facilities management kind of project. Me: we consider a new building as being a new product.
So, its probably a high standard of technical expertise, I mean people its always been the strength of Company D, and its always been regarding as a company which provides the industry with highly capable people. That’s probably it.

The design and construction process

6. Can you describe the process model - the main activities in a project?
All building construction projects, from my point of view, come down to 2 distinguished phases, one is the tendering phase and the next is the construction phase, and there are some phases within that. Tendering process is very different accordingly to the different kinds of work and from which source those come from. With design and build, which is what we are talking about at the moment, we usually have to go through a pre qualification process to get
ourselves on to the tender list, to be able to tender the job at all. And in some cases the pre qualification process involves a great deal of work, particularly with PFI or project private partnership jobs. You have to take work a long way down the line, including the design of buildings … the reason for this is to achieve a certain degree of cost certainty, otherwise we loose money. But we do all this…

So the process basically its pre qualification, and its unusual to be given a tender opportunity without such a pre qualification, on the size of jobs we do. Some times is rather cursory, some times it’s very important. And sometimes it’s a broad design, sometimes it involved a considerable degree of design. And we have this … within this process …on time, service, we know that there are things we haven’t covered and that there are things we cant determine in the outcome and we keep those under reviews and we record it at the end of the day, of course on price and some kind of other information. If you ask us to take the whole risk we have to put a figure to it.

The next stage is once we successfully submitted a tender, and it will usually be with a fairly bulky design document which set out how to praise design methodology, the team of people we are going to use, and this sort of things. Once we have got the job there is then an organisational period where everything comes back to us and then we have to check it all again, making sure there are no changes since we last priced it, we have to set teams up and we have to organise the premises to put the selected teams in and we have to do the design because we have to plan all the construction, that’s part of the tender stage, so its all then reviewed, programmes are reviewed, project managers … is finished, and big projects are generally are send to a new team of people so that … so it’s a kind of run off pit in each project. And the first stage, depends on how much design work there is to do, how much leading period we have, we have a whole….. we’ve soil investigations going on, existing buildings, services, so that sort of thing. The rest of the design is completed by consultancy people that have… the tender stage… unless there is a particularly unsatisfactory experience, we than change them. And then we start building. The process of construction starts before design is finished, so details, much details, are produced usually during the early stages of construction and all has to be changed in a different time, into the tendering packages, and letting all of the to the organisation of the subcontractors, that will do the work. Towards the end there is an increasing period of inspections by the client assigned (or at site), and large numbers of … of have to be produced to assure that the building is put at standard that the client wanted. Then we hand it over, we stay at the site for a while but with reduce staff only to do minor things and correcting some things for the building to be corrected and then handed over. … people are dispersed and go to a new contract.

7. **Is there a certain amount of the design that is expected to be completed after the tender?**

Well, you don’t do anything between submitting the tender and having the result, because you are just increasing your risk since you don’t know if you are gong to have the job or not. So the
design bids is at a stage where you have sufficient information on the detail to be able to price it reasonably accurate, there is a contingency … to allow for design development, but it is usually a very small percentage. So we need the design to be understood in much detail really. I mean a lot of the drawings which comes later are not design drawings, they are actually fabrication drawings, you know, the steel, composite concrete slabs or things like that. What we haven’t got is all the drawings laying out all the shits and all the … and we hold that uncertain, that part we estimate, so there is a lot of complication in drawings and there is a lot of small packages which are unfinished when we are bidding out a building. Where we might not have a design to tender we may have to put the details of drawings, so there is something that we need to do.

Also, you said that the design are developed accordingly to the necessities of the construction, so the design schedule is tight with the construction schedule? Absolutely. I mean the construction programme is broken down to its packages and it will give you the starting dates of those packages. You have to work back from that and allow a changing period, or first of all the mobilisation period of the subcontractor, and then the tendering period, and that’s the last day for the design of that particular package to be finished. So we pull out the design programmes from the construction programme.

8. What is novated?
That is a legal problem. That means clients have subcontracted the designers themselves, so we take the design at a certain stage where he is satisfied and he’s assured he's going to get the building he wants. He then offers a tender to contractors such as us to complete the design and do the building. That in the case of novation it means that we have to take all the risk of the others … so novation is a legal term and it means taking all clients architects in the same terms of his contract. That presents us with another little problem because his terms are possibly not, his schedule of services that he expect the architects to provide are possibly not the same as our terms, as the things that we expect them to provide. So we have to have another cotation of services that we want them to do.

9. What’s the difference basically between the gates and the control points?
The gates are envisaged as director’s level approvals to go ahead. And the control points are down at the site management level, it’s really that the design itself brakes down, the RIBA plan of work as you know defines stages, so we just implement a checking process, so that you check what you have done before you move one. So you see what you have and haven’t done so you know what’s happening.

10. And you have any procedure on how this control points will be made?
This is all of a process, … we got the design at a certain stage, we check it and make sure that it is going in the right direction, and its right sort the costs, and the bid managers is happy with
it, and then we move on. We hope to get the client to sigh off the draft project brief and any qualifications about it and the design as well. So you carried out you risk checks, and you drawn a line and you know where you are and …. And you are sure it is ok. Then if the bid manager is happy you can move on otherwise you have to go back and change it. In a sense you don’t actually need to right it down because its been happening anyway, but in effect it doesn’t happen quite well all the time, but it is a process anyway.

(He was very uncertain and he could not explain really what it is all about….)

11. In the process model – colours: What’s the difference between the green the yellow and the green?
The green is pre qualification process, yellow is tendering and the orange is building. And we use that even in black and white versions but that was not corrected yet.

12. Why you draw design management together with the bid process?
Well, there isn’t a process for the bid process yet. This is not the bid process, this is the management of design and when I started working on this one it got enormously complicated because I was tracking bid for all the different types of contracts to it and it was turning into a bid process management map, of which design was a feature, and it became … and at the moment I just pushed all this boxes up here, so this is somebody else’s job, you know there are other things that have to do with bid but not with the design, and I’m concentrating on design, and that will only reflect the management of design within the context of the contract but it wont reflect how it has to be done. But I had to draw part of the bid process because there are interfaces with bid management but I’m not briefed to do the whole thing.

This is just a map for the different contracts we are likely to do. In one stage design and build once you pre qualify you develop the design and bid it, and then if you get the job you build the building. At the 2 stage you pre qualify, you develop the design up to a certain stage, you make a bid on the basis of it, and then you complete the design on a second stage, you resubmit the bid and then you go on and build it. PFI – private finance initiative – it’s the previous governments, conservative government programme to do public private partnership. There is still a lot of PFI going on, particularly in hospitals. This is really like the others, except it iterates all the time you develop a design, you make a kind of bid which is called a provisional interest (or intention) to negotiate, and if you get to that stage, you are still in competition with several other contractors, you develop the design and then there is an intention to negotiate, and then you develop the design again and you make your best and final offer, then you became the preferred bidder, you take the design even further, and then the design is signed off, it is financial closed, and at end of huge amount of money and a lot of time you will get the job. But then it is going to be 200 million pound or something. That’s what you do.
13. And then each contractor that are bidding they have their own designers?
Yes, yes. And sometimes you can still fail on those jobs, sometimes for political reasons, or the client resigns, and you lost all your money.
On the 2 stage design and build you have your own designers all the way through, and you just do it in tow stages, so the first thing to do is a kind of mock up, and if you are successful with that you then proceed with developing the design. And that will probably be the only one, or it might be done in two stages.
This one, the orange means that you don’t have the designers, the contractor is giving construction advice, and we are not taking any risk with that. So the first thing is your fee to take it to this stage, so you already have some profit for this stage. During this time you act very much as a project manager or an expert in construction, so the client is controlling and you are only busy managing, setting up meetings, coordination’s, and you are injecting your expertise in construction. At this stage you quote a guaranteed maximum price to take the job one. And that was the one I worked on that didn’t turn up ok, and we have to put an extra million pounds that we didn’t wait.
The construction management occasionally happens, and we don’t have any risk at all. You still need to do design management. The process of design of course is the same in all cases. The process of managing the design is similar in all cases as well. So once you design to limit this map to the process of managing the design you don’t have to worry about all different types of contract.

14. So you believe that the different types of contracts won’t change the activities of the process?
No they don’t. I mean when we are talking about controlling risks and so one if you think construction management is actually the difference is that it is not your risk is the clients risk, but your duty is to control them anyway.

15. How is the development of each project process defined between specialists…
You mean within out company? Yes… (he dint understand it.)
Within the company we have a project management system, there is a QA system for project management and … it isn’t complete, it is incomplete. The project manager has a lot of powers, in terms of regions, in terms of defining in detail how hi is going to organise it, and each particular region has their own philosophies…. They are self-contained and they don’t allow anybody in so we can’t see what they do… And this makes the implementation of a process map not easy. so something has to be changed.

16. How the members of the team organised the stages of development?
There is a fairly standard risk responsibility treat within the design team and basically there is a project manager overall, and then there is a project accountant in the side, there is a construction manager who brakes down into various sections or packaged of the work, … and there is a
planning manager, who does the programming, there is a commercial manager who controls the costs and payments, and there is the design manager, who manages the design.

*The tape stopped*

I mean the same tools are used to do the design programmes. We report schedules and deliverables …

17. **Are the process characteristics agreed between stakeholders? How? How the process is going to be used?**

How I hope its going to be used is that they take the process seriously and if they decide not to do anything they decided it consciously and responsibly and put some other checking process in place to make sure that if something goes wrong they make sure that is not the commissioning that suffers. But I mean it will be necessary, that piece of process in some situations, the reality is that for competitive reasons that’s never done from the start, and people don’t have time to do that anyway so if you have the change the process map every time you start a project it probably wont happen.

That’s the reality. It should be done. The intention of the process map is to present an example of a typical kind of job, that some managers should sit down and adjust it accordingly to the type of job. In reality it probably won’t work like that. It is not unusual, it is not out of the question to arrive on a site and then you need to finish it in one month. You feel as if you are in a military camp, because of the pressure.

18. **In your view, which are the main problems of design management within Company D?**

Well everybody will acknowledge that the first problem is getting the drawings out of the designers, getting adequate drawings out of the designers in time, of course. And the next problem is probably controlling the clients briefing and specifications, which cost too much to get the client in a job which they think they can’t pay for it ?. and the third problem will be our own architects and engineers inadequacy to some extent, I mean, as I said before it is the team of people you work that is more important. And you can’t always have the right people for your job, and you can only deal with this sort of problem when it happens. When you are selecting the people is impossible to know that and to control that. And designers tend to have their own agendas, they are more interested in aesthetics, and they are interested in reducing their own costs, as much as possible. And really we cannot afford to ignore the aesthetics because for the client it is important, and thus it gives us more jobs, but at the same time there is the real business outside which cant afford buildings to be expensive.
19. The first thing you said is that getting the drawings from the designers is a problem. Do you believe that the company can control this quality in any way? This is what... We can't ignore that... but I think the quality of the drawings, it is an issue but is not as big an issue as picking them up on time. The biggest problem is actually getting them on time.

20. And this is a problem because of the different interests of the designers and Company D? It is a problem because of capitalism, we have pressures and they have pressures, and if we can't cope they can't cope with it....

IBP programme

21. Why do you think this programme started in the company? Because of the cost of having an unsuccessful project. So it's a matter of eliminating or controlling the risks.

22. Are the process models being developed separately? How will they be integrated? Yes we do intend to integrate it. They are being developed separately. Mine is going to be the second one, the planning model started some time ago, have you ever seen that? We have a planning process map, and it looks like that, and the information explaining it should be available for anyone. If you read that one and if you like computer programming you can actually be a planner. That's how good it is. This is also on the internet. There is a book that explains it all.

The question was about interfaces. I think the answer is that it's a lot of an effort to produce this first, and its much easier to then try to build up the interfaces. I haven't done this yet actually, but ... you have to do one at a time because otherwise you will never do it, and then link it together, that's the answer.

23. Have you ever seen the process map developed by the [consultancy company]? Are you using any of that information to build the process model? The [consultancy company]?? (what is that?) Well, I never used it. Why, I should?

I'm building it simply by asking the question: what do we do and what should we do?

24. Are you discussing the model design with others? Yes we have a management committee of valuable people... and I draft the model and then send it to them to give their opinions about it, and it goes to different regions. Different regions have different interests and they are not really going to buy-into the process model.
25. In your view what are the benefits of having the process models in the company portal?
The benefits are that they are accessible to anybody. The problem is that everybody has to be literate enough to use them. And unfortunately that is a problem, really. The problem of the other project was that we didn’t have support from the top management so we changed the process in the paper but not in reality…

26. What are going to be the payoffs of using the design process model in your view?
Hopefully we should make less mistakes. And we should therefore not suffer from great losses in projects, and improve profitability. Those are the primary benefits. The reason being is that you are going to analyse and reduce the risks and we will anticipate the problems throughout the company. These are the benefits of the process model if it is properly used, and it needs trust for it to be used…. A part of our contracts is to do the job properly without costing more, and measure it against those who are also doing it properly, as long as they want to go and measure us against companies that do design and build, Company D is a kind of expert in that.

27. At which stage of the model development are you in at the moment?
We are somewhere between half of the programme for the year, and that’s the development of the model, and we are in the process of developing the documentation at the moment. And after that there is training and piloting. Do you know when you are going to pilot it? no, no yet. I don’t think there is a project were we are going to pilot it defined yet.
(he gave me a copy of the plan of activities)
I don’t understand everything that’s on it, sorry about that. I didn’t do do programmes, so that’s why.

28. The design models have to refer to the planning one, in terms of format?
We are endeavouring to make it similar, because the planning one is quite accessible and simple and very successful, and for sake of consistency, and for making it easier for people to use it, I’m trying to make it in the same format. …
One of the important things about this is that although a lot of things could be banished or done in a different order, this is basically a sequential model, and it is necessary that a lot of the things are done in the time shown. If you make it too generic then people could do whatever and then we would miss the goal of it, so anybody could do it accordingly to his perception.

I explained the work I’ve done in Brazil.
I can see the problem of that would be that you will be giving people an excuse to bane it, to sort of jump activities, because they haven’t done what they should really.

29. Why the guide notes haven’t been fully used in the company before?
Because it wasn’t promoted. It didn’t have a proper launch.
30. Why do you think a process model is being devised?
Why a process model? Again, it is to have a mechanism to controlling it, is there any other reason? It is a control mechanism. And it is dangerously getting close to a QA system, it probably is a QA system.

31. How is the model being devised? How do you define it?
This is only a logical diagram, and the fact that it has got two columns in part a historic one, because in the beginning it had five, accordingly to the type of contract. I retained two because there were some alternative routes in some cases, such as here, and if you are selecting designers from our proofed supply chain list the process would be simpler. If you have to select others, than it is a more elaborate process. But the two start at the same point and end at the same point…. So I’ve left the two columns, but as I said this is just a temporary format, its just to make it easy to communicate, that’s the intention.

32. How do you believe that the process model is going to be turned into a usable document?
We have a consultancy firm, who is the same person that produced the planning model, so hopefully when this come to a proper standard here, we …. That’s the use of the consultancy, they are going to (produce the formatting of the model) and use their lawyers to … evaluate legally the model(?).

33. And what about the agreement between all the Company D participants?
Yes, interesting question, this thing has been distributed between my colleagues, and there are some issues. There is a particular issue, which is a question of how much discretionary the design managers should be given over drawings, one school of though is that we employ expert consultancy, and they should be responsible for the drawings, and the other school of though believes that the design consultancy don’t always do what they could, and they don’t get in any trouble if anything goes wrong. And that actually happens for all companies…. The real kind of bulk(?) in it comes from the fact that we have a large number of people doing design management but they don’t actually know how to do it - are not qualified to do it, … because they don’t really understand the design process …. So the only thing that they can check it for is if it is buildable, and relatively simple plans, quality plans. So most of the things … tend to operate as information coordination, its just pushing drawings out of the people, without really analysing quality or the process. The answer to that is training, making sure that they understand a bit the design process…

34. How do you think that the design model is going to be used then? As a basis for designing the project process and as a guide?
The final model? It should be used as, well, it is going to be a mandatory process throughout the company, and it should be owned (?) as well.
It should become mandatory, this is the intention of it. I accept that there has to be some flexibility within the process because … but probably …

35. How do you think the model is going to be applied for different sizes and types of contracts?
That is a thing that we haven’t touched yet, I mean that’s the ideal model of course and its written very …projects. Company Ds isn’t supposed to be doing anything under 2 million pounds, but in fact most of the project processes are sort in between 5 million I suppose, things like supermarkets and things which are done in design and build, and usually we have the design already and we will then just adjust it. the answer is I don’t know yet, but it is really a problem to be addressed.

36. How training is going to be addressed for the use of the design model?
That’s under discussion at the moment. There will be training on this for managers, there will be recruitment of new design managers, and they will have to use this as soon as they get there, that’s the kind of model they are suppose to be using. I think the very highest level of the company, managing directors,… will have to direct the appliance of this, and between of us we will have to decide the training for this.

37. Which do you believe will be the implementation steps for the design process model in your view?
Its obviously going to be law in terms of new projects in the company, and will be consolidated process…throughout the country… to instruct people and show them how can use it, and I don’t know more that that.

38. In your view which are the inhibitors involved in the adoption of the model?
The lack of financial support to, and increased overhead for a job, the lack of knowledge of the people who has to apply it, to do design management, particularly on terms of drawing,…, general knowledge I believe.

39. How the process model will be changed to keep up with changes in the business environment?
I think the programme has to drawn up a policy for that, but obviously has to be reviewed and updated. There will be a feedback into the system, and the model could be reassured periodically between the members, we will ask them a whole list of things to do, and there must be leadership there.

40. How is the design process monitored and controlled in practice now?
Its monitored against delivery dates, …that’s sure, and we have the COMIST, which is a system that monitors the production of drawings and produce very sophisticated reports, and it
indicates whether drawings are not in position(?), whether they been changing and approvals, as they should, basically it tracks the whole process…

41. Do you use performance indicators? KPI’s?
No. I cant think of KPI’s in the design process.

42. Do you intend to include them or not?
There is important to have performance measurement really. I mean there are others KPIs, but the design managers are supposed to be visibly designers, so they can check and within the design offices they must have systems to check it as well. And also KPIs to check if they are implementing it or not. I don’t have the answer for that.

43. Are there progress reports or evaluations during the process?
Yes. (He didn’t describe them).

44. In your view which are the main problems relating to design control?
(he didn’t know how to answer)
Does that mean actually requesting changes from it, to correct it?
I think it’s the usual difficulties, the relative inflexibility of small design teams, I mean not many of the designers or offices that we subcontract for a design will design have very large design teams, so they have little flexibility and sometimes they get short in people as well. Although we are monitoring that, we are realising that sometimes it might be true, and sometimes we have to actually get them to increase their resources in order to fulfil our needs, but its pretty difficult to achieve that. they are usually in a market that the least … anyway. So the biggest problem is actually being able to put a lot of pressure to that and get it to change.

45. How is the team organised for each project? Have you seen a typical diagram for that?
(He gave me a copy). That’s a pretty old one.
These are the proposal that come out of the tenders… (the ones I saw there), those are the contractor’s proposal docs (in the model). So the design manager has to visually put this together, and it will include drawings, some developed design ideas, some specification, which may be more or less developed, and the project team as well, and programmes for the main stages.

46. The stakeholders get involved when?
The bid team is different from the construction team. The intention is that the project manager that will construct it gets involved in the bid, but what normally happens is that when they finish one job and before they get to another one they will probably get involved in three or 4 bids, before one actually starts. So there is often no continuity between the bid and the construction team. We do have a hand over meeting where the bid team goes and explains to the construction
team how they put it together, and how they priced as well. We should try to retain at least the project manager, but that doesn’t happen. The biggest difficulty is that we don’t know when we are going to get a job.

47. Which means of communications are used commonly? In some projects are fully computerised, including all the drawings made by computer, and others still operates with no more than a fax machine. It really depends. In some of them probably only the project manager has his laptop and that’s about it. That’s to change though. And the performance of the communications will improve as well.

Thank you, FINISHED!
Appendix C: Methodological issues: specific data collected and analysed

PRELIMINARY CASE STUDY COMPANY A

The following sources of qualitative data were used in this exploratory case study:

(1) Two two-hour semi structured interviews:
   - Interview 1: Vice president of performance management, on the 5th of February 2002. He was one of the process models developers in the company; and
   - Interview 2: Projects development manager, on the 15 February 2002. He is responsible for the process model’s adoption within the company different business units, as well as for the project managers training.

(2) Company documentation:
   - *Internal publications*: (a) New Product Introduction (NPI) Process Handbook: This document details the process from a supply chain perspective i.e. describes the process as a series of sub-processes linked by inputs and outputs, providing a multifunctional view. The model is used to train new NPI managers (and others) as well as to analyse NPI activities for improvements; (b) Life cycle management: a guide to phase reviews: describes the lifecycle management model, including its key principles, phase reviews, concurrent engineering and project management issues. (c) Life cycle management: a guide to usability: it complements the guide to phase reviews, describing links between usability assessments and phase reviews, aiming at increasing the project focus on user needs. (d) Global solutions management: the business process model that was under development by the time the interviews were undertaken.
   - *Company information*: available in the Internet.

(3) Workshop
   - Vice president of performance management’s presentation on the Process Network\(^{26}\) workshop on process models implementation, on the 20\(^{th}\) of November 2001.

(4) Informal telephone conversations to confirm the results from the analysis developed by the researcher.

\(^{26}\) Information on the Process Network, a network on process knowledge funded by the EPSRC, can be found on the web page: http://www.processnetwork.org.uk
PRELIMINARY CASE STUDY COMPANY B

The following sources of qualitative data were used in this exploratory case study:

(1) Interview 3: One two-hour semi structured interview:

- Business Services Manager, working within the Nuclear Business Stream of the company, which develops projects for the nuclear sector. He is responsible for business performance, business improvement, total risk management, information technology and documents management. Therefore, he is responsible for activities related to organisational change, including process development and improvement.

(2) Company documentation:

- **Internal publications**: (a) XX alliance programme and key deliverables; (b) top issues and actions on the development of the XX alliance; (c) key deliverables on the delivery of KPIs for the XX alliance; (d) SWOT analysis for a group of process activities (not complete); (e) BTC Procurement process map – as-is and to-be; (f) able describing issues and questions raised during interviews – BTC; (g) BTC project implementation programme; (h) key improvement proposals for BTC; (i) agenda for project review meetings.

- **Company information**: available in the Internet.

(3) Informal telephone conversation to confirm the results from the analysis developed by the researcher.

PRELIMINARY CASE STUDY COMPANY C

The following sources of qualitative data were used in this exploratory case study:

(1) Interview 4: One two and a half hour semi structured interview with:

- The managing consultant working in the infrastructure solutions area. He was directly responsible for setting the partnership arrangement between the company and 5 construction contractors, and was directly involved with the process model design.

- The operations director for the infrastructure solutions. He was also responsible for the process model design and implementation.

(2) Company documentation:

- **Internal publications**: (a) company organisational structure; (b) a hard copy of the process model; (c) description of performance indicators developed as part of the process model; (d) company leaflets.
• **Company information:** available in the Internet.

(3) Workshop

• The managing consultant presented the partnering approach adopted by the company on the Process Network workshop, on the 8th of February 2002.

(4) Informal telephone conversation to confirm the results from the analysis developed by the researcher.

**MAIN CASE STUDY: COMPANY D**

The following sources of qualitative data were used in this exploratory case study:

(1) Four two and a half hour semi structured interview with:

• Interview 5: The responsible for Information Technology development at the company, which is involved as a board of the IBP programme in its IT work package, on the 30th of May 2002;

• Interview 6: The quality assurance manager, also involved in the IBP programme by supporting the programme manager, on the 6th of July 2002;

• Interview 7: The senior design manager in the company, responsible for designing both the design and build guidance notes and the design management process model;

• Interview 8: The design manager responsible for the pilot implementation of the process model in the design of a hospital.

(2) 14 informal meetings with design managers and with the project manager responsible for the IBP initiative.

(3) Company documentation

• *Internal documents:* Design management (DM) process map – high level and linked to the bid process, 3 versions during its design; DM map – gates and description of what should be done – activities; Map linking design and BID processes; DM model training programme; Copy of the management information report from Company F (consultancy work); Copy of the high-level project process map drawn by company F; Mistakes made and lessons learnt in design and build projects; Designer performance review form; Management system procedure: management of design during bid preparation; Design & build guidance notes – a map of design management activities; Consultancy agreements for full design and for design development; Hospital project bidding documentation, including list of deliverables, list of contacts – project
participants, schedule of DM meetings, presentation of the consortium (power point slides), Consumerism pro-forma.

- **Internal publications**: such as Blue print (the company newsletter)
- **Company information**: available on the internet.

(4) Informal e-mails and telephone conversations.

Data collection diagram:
Appendix D: List of categories and codes

The list of categories and codes presented below is the final version used for analysis at Company D.

<table>
<thead>
<tr>
<th>Codes – descriptive label</th>
<th>Research question</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROCESS</strong></td>
<td></td>
</tr>
<tr>
<td>Implementation Strategy</td>
<td>3</td>
</tr>
<tr>
<td>People involved in IBP</td>
<td>3</td>
</tr>
<tr>
<td>DM implementation strategy</td>
<td>3</td>
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<tr>
<td>DM impl. strategy/steps on modelling</td>
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</tr>
<tr>
<td>DM impl. strategy/Info used to build the model/hard data</td>
<td>2,3</td>
</tr>
<tr>
<td>DM impl. strategy/Info used /users requirements</td>
<td>2,3</td>
</tr>
<tr>
<td>Improvement initiative steps/activities planned but not done</td>
<td>3</td>
</tr>
<tr>
<td>Model Use</td>
<td>2</td>
</tr>
<tr>
<td>adaptation</td>
<td>2</td>
</tr>
<tr>
<td>adoption</td>
<td>2</td>
</tr>
<tr>
<td>adoption/Readiness</td>
<td>2</td>
</tr>
<tr>
<td>adoption/Critical events</td>
<td>2</td>
</tr>
<tr>
<td>perceived benefits</td>
<td>1,2</td>
</tr>
<tr>
<td>Impacts</td>
<td>2</td>
</tr>
<tr>
<td>user experience</td>
<td>2,4</td>
</tr>
<tr>
<td>changes in the process model</td>
<td>2,3</td>
</tr>
<tr>
<td>effects on organisational and project practices</td>
<td>2</td>
</tr>
<tr>
<td>implementation problems and explanations for failures</td>
<td>2,3</td>
</tr>
<tr>
<td><strong>CONTENT</strong></td>
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<tr>
<td>Knowledge complexity</td>
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<tr>
<td>Knowledge transfer</td>
<td>3</td>
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<tr>
<td>Model objectives</td>
<td>2,3</td>
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<tr>
<td>Organisation of the model (information structure)</td>
<td>1,3</td>
</tr>
<tr>
<td><strong>TRIGGERS</strong></td>
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<tr>
<td>Why implementation is needed</td>
<td>1</td>
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<tr>
<td>Why the improvement initiative</td>
<td>1</td>
</tr>
<tr>
<td>Why a process model</td>
<td>1</td>
</tr>
<tr>
<td>Goals/objectives of implementation</td>
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<tr>
<td>Expected benefits</td>
<td>1,2</td>
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<tr>
<td>Improvement concepts and principles</td>
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<tr>
<td><strong>OUTCOMES</strong></td>
<td></td>
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<tr>
<td>Perceived gains and losses</td>
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<tr>
<td>Stabilisation of implementation (and behaviour)</td>
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</tr>
<tr>
<td>User-level outcomes/positive or negative, anticipated or unanticipated</td>
<td>2,3</td>
</tr>
<tr>
<td>Organisational level outcomes/positive or negative, anticipated or unanticipated</td>
<td>2,3</td>
</tr>
<tr>
<td>Implementation effects/positive negative, anticipated, unanticipated</td>
<td>2,4</td>
</tr>
<tr>
<td><strong>INTERNAL CONTEXT</strong> (descriptive information)</td>
<td>Descriptive info</td>
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<tr>
<td>Implementation history</td>
<td>Descriptive info</td>
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<tr>
<td>Why previous models were not used</td>
<td>Descriptive info</td>
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<tr>
<td>Company characterisation</td>
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<tr>
<td>number of projects year</td>
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<tr>
<td>procurement systems</td>
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<td>projects commonly developed</td>
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FACTORS AFFECTING IMPLEMENTATION

<table>
<thead>
<tr>
<th>Communication effectiveness</th>
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<tbody>
<tr>
<td>Arduous relationship</td>
<td>4</td>
</tr>
<tr>
<td>Content of the process model</td>
<td>4</td>
</tr>
<tr>
<td>Problems</td>
<td>4</td>
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<tr>
<td>Measures of performance</td>
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<td>Completeness</td>
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<td>Unproven knowledge</td>
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<tr>
<td>Process innovation</td>
<td>4</td>
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<tr>
<td>Causal ambiguity</td>
<td>4</td>
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<tr>
<td>Effective implementation strategy</td>
<td>4</td>
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<tr>
<td>Proper launch</td>
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<tr>
<td>Programme to implement</td>
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<tr>
<td>Follow up after modelling</td>
<td>4</td>
</tr>
<tr>
<td>Training</td>
<td>4</td>
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<tr>
<td>Compulsory document</td>
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<tr>
<td>Adopted from the star of project</td>
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<tr>
<td>Key functions</td>
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<tr>
<td>Not all areas are considered</td>
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<tr>
<td>IT support</td>
<td>4</td>
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<tr>
<td>Use to publish model</td>
<td>4</td>
</tr>
<tr>
<td>Difficulties</td>
<td>4</td>
</tr>
<tr>
<td>Organisational and project context</td>
<td>4</td>
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<tr>
<td>Barren organisational context</td>
<td>4</td>
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<tr>
<td>People</td>
<td>4</td>
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<td>Top management support</td>
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<tr>
<td>Couldn’t be bothered-too busy</td>
<td>4</td>
</tr>
<tr>
<td>Capable people</td>
<td>4</td>
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<tr>
<td>Source not perceived as reliable</td>
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<tr>
<td>Source lacks motivation</td>
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</tr>
<tr>
<td>Recipient lacks motivation</td>
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<tr>
<td>Recipient lacks absorptive capacity</td>
<td>4</td>
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<tr>
<td>Buy in</td>
<td>4</td>
</tr>
<tr>
<td>Well defined roles</td>
<td>4</td>
</tr>
</tbody>
</table>

DESIGN MANAGEMENT (only Company D)

| design planning          | Extra info |
| control-reviews          | Extra info |
| activities               | Extra info |
| strategy                 | Extra info |
| selection of designers   | Extra info |
| problems related to design mgmt | Extra info |

Research questions:

1. What are the improvements to current practices brought about by process models devised/implemented in construction firms?
2. Are the espoused benefits of process models achieved in practice? And if not, why are process model implementation efforts often unsuccessful in practice?
3. How do project teams implement PDP models? and
4. What are the factors influencing the success or failure of the implementation of PDP models in practice?
Appendix E: Extract of a log of case studies activities

An extract of the log of research activities as kept during the development of the case study with Company D is presented as follows.

<table>
<thead>
<tr>
<th>Date</th>
<th>What &amp; where?</th>
<th>With whom?</th>
<th>Data collected</th>
<th>Reflections, comments</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>08 April 2002</td>
<td>Meeting @ Company</td>
<td>G.R.; J.B.; M.B.</td>
<td>Presentation of research; Assessment of willingness to participate</td>
<td>Company interested in implementation – good potential for action research</td>
<td>Case studies.doc, Presentation for co$tain.doc, Minutes.doc</td>
</tr>
<tr>
<td>16 May 2002</td>
<td>Meeting @ Salford</td>
<td>M.B.; M.K.</td>
<td>M. B. presented the company improvement program. I described again the research and possibility of further work with the university; he said I could do the case study.</td>
<td>Improvement programme seems to focus mainly on IT.</td>
<td>File of the presentation.pdf sent by e-mail</td>
</tr>
<tr>
<td>30 May 2002</td>
<td>Meeting @ company</td>
<td>J.O.; T.B.</td>
<td>Description/presentation of the IBP programme</td>
<td>Company has previous unsuccessful implementation experiences!!</td>
<td>Presentation2.pdf slides, Minute2.doc</td>
</tr>
<tr>
<td>6 June 2002</td>
<td>Interview @ Salford</td>
<td>T.B.</td>
<td>Interview – data collected included various documents Transcript *Files available at Company D’s files</td>
<td>Very rich interview data – IBP programme focus indeed in process improvement; problems usually focus on people issues</td>
<td>DM map – high level and bid process; DM map – gates and activities Management information report from company F; High-level project process map drawn by company F Company F model; Initial pre-contract letter Mistakes made and lessons learnt in design and build projects Designer performance review Management system procedure: management of design during bid preparation; Design &amp; build guidance notes – a map of design management activities this document will be replaced by the new model Consultancy agreements for design: architects, service eng., structural and civil engineers.</td>
</tr>
</tbody>
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