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# Implementation of product development process models in construction companies

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**ABSTRACT:**

Process models have been developed by academia and industry to enhance the design and construction activity. However, effective and widespread adoption and use of such models in practice has been limited. This research investigated the dynamics of product development process (PDP) models implementation in construction companies. Four case studies where undertaken, and key findings emphasise the need to consider the *design* and *implementation* of PDP models in an integrated fashion within the organisational context in which it takes place; and the need for a shift in the role of PDP models from a rational 'planning and control' perspective to a softer 'learning' approach.

**KEYWORDS**: product development process, process modelling, implementation, construction companies

## 1. INTRODUCTION

The UK construction industry is constantly challenged to deliver projects that are predictable on cost, time and quality, through an appropriate understanding of customer requirements (Egan, 1998; DTI, 2002). A key part of this broad agenda relates to the need for improving design and construction process performance. Numerous government and institutional reports examining design and production in the construction industry have constantly highlighted the need for innovation and change in process management practices (e.g. DTI, 2002; Fairclough, 2002).

A critical improvement strategy which has been proposed is the design and implementation of generic process models, which would allow for a consistent and integrated design and construction process (Kagioglou et al., 1998). Even though relationships between stakeholders are complex and dynamic in a project environment, the underlying generic processes remain broadly consistent (Mill and Ion, 1994; Kagioglou, et al., 1998). As a consequence, process mapping has been widely accepted as an important vehicle for performance improvement.

The effective adoption and use of process models in practice, however, is 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 50-70% of Business Process Reengineering (BPR) initiatives. Several reasons have been pointed out for this. Cao et al. (2001) and Hengst and Vreede (2004), for example, argue that human issues connected with process management initiatives often receive insufficient attention. Within this advocated human-centred approach, Lawson et al. (2003) state that model failures occur due to lack of motivation, with many process maps left unused on the shelf regardless of the time, knowledge and effort invested in developing them. The normative logic for generic processes is still strong, despite the growing empirical evidence which express widespread failure. There is an urgent need to investigate the reasons for these failures, to rethink the normative concept of generic processes, and to better guide implementations so that firms can realise espoused benefits from adopting PDP models.

The paper is structured as follows. First, a literature synthesis describes perspectives on the implementation triggers, outcomes, process and content. Second, the research method adopted is described, including its justification and limitations. Research results are then presented for the four case studies undertaken. Finally, conclusions are presented describing implications for theory and practice.

## 2. LITERATURE SYNTHESIS

The implementation of PDP models can be analysed from different theoretical perspectives, in order to provide a more holistic and systemic view. Three complementary perspectives will be discussed: *process management*, describing implementation triggers and outcomes; *change management*, analysing the implementation process from a managing people through change perspective, and; *knowledge transfer*, looking at the technical content of the process being implemented.

### 2.1. Process management perspective

Construction process management practices focus on both design process management (the central point being managing the production of information) and on construction management (managing the physical production of a facility). In this research, a broader perspective is adopted to design management, borrowing the concept of Product Development Process from manufacturing. This aims to make explicit the importance of considering not only design, but also the interfaces

between design and other processes during the preliminary phases of construction. Investment on high quality PDP 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 begins with the perception of a market opportunity and typically involves the capture and management of customer requirements, concept development, product design, market launch, and collection and dissemination of feedback data (Cooper, 1998; Yazdani and Holmes, 1999).

It has been proposed that the means to navigate through, and reduce, product development complexity is by the design and implementation of appropriate generic process models (Cooper, 1994; Kagioglou et al., 1998; Which and Carr, 2001). The triggers for implementation in practice relate to the potential to achieve some benefits that have been claimed by the use of such models. Espoused benefits relate to the client, i.e. potential improvements to the product; to the process, focusing on the way it is developed; and benefits for the organisation as a whole.

The most important espoused organisational benefit stressed in the literature is achieving process consistency and integration and, as a consequence, more predictable outcomes through the replication of managerial practices embedded in all company projects (Kagioglou et al., 1998; Ulrich and Eppinger, 2000; Cooper, 2001; Winch, 2003). Furthermore, a process model can act as a support for development and training on ‘process thinking’ (Gray and Hughes, 2001; Cooper, 2001).

A process model specifies the phases a project should go through and monitoring/decision checkpoints along the way (Wheelwright and Clark, 1992; Cooper, 2001). Following the model is one way of assuring quality (Ulrich and Eppinger, 2000), reducing cycle times and costs (Reinertsen, 1997; Kagioglou et al, 1998; Cooper, 2001). Furthermore, stakeholders' roles can be clearly defined (Gray and Hughes, 2001), as well as when their contributions will be needed and with whom they need to exchange information (Ulrich and Eppinger, 2000). For clients, the benefits accrued from the process approach are better value for money through a product free of defects, which fits purpose, and which is delivered on time (Reinertsen, 1997; Kagioglou et al., 1998; Ulrich and Eppinger, 2000).

However, Maylor (1997) discusses that empirical studies normally describe benefits, but they do so regardless of complementary activities that might be taking place within firms. Consequently, it is difficult to determine if the benefits claimed are directly derived from the use of a process model or if these are by-products of the use of other techniques. Furthermore, although the organisational context is extremely important in determining the relevance of a process model (Pettigrew, 1987; Bresnen and Marshall, 2001), this issue is abstracted away from most studies on process modelling.

The understanding of process model implementation within the process management literature is limited, and we discern three main causes for this. First, process model design is a difficult, long-term exercise involving different knowledge domains (Formoso et al., 2001). Consequently, studies tend to focus on the model design, leaving implementation as an area for further research. Second, most models in the

literature have not been developed considering empirical evidence, nor have been empirically validated, which suggests that the research strategies applied do not lead to the consideration of the implementation phase. Finally, implementation is multifaceted, complex, and tends to be context specific, making the generalisation of results from empirical studies difficult.

It is argued here that implementation should be explicitly considered within the specific context in which it takes place - especially where companies design 'in-house' models. Therefore, the model itself directly influences implementation success. Implementation success should be measured on the basis of benefits achieved against the anticipated benefits. From a process management perspective, two research questions are thus supported:

- What are the actual 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 not successful in practice?

### 2.2. Change management perspective

The 'implementation process' refers to the steps a firm should go through to fully operationalise a process model. The New Product Development (NPD) literature presents generic guidelines for successful implementation. In addition, the organisational change literature presents change management models, which have also been applied to process model implementation.

The NPD literature often presents ‘processes’ to implement ‘processes’. Cooper (2001), for instance, presents a model with three stages: (1) defining process requirements; (2) designing the model; and (3) implementing through training, internal marketing, and a process ‘owner’. A similar model is presented by Smith and Reinerstein (1995). It can be argued that if there is a need for a process model to implement a process model, maybe there would be a need for a further process prescribing advice on the process to implement a process model, which could lead to a never-ending cycle!

Similarly, several conceptual models and methodologies for successful implementation can be found in the BPR literature. Even though such methodologies have been developed with different focuses, common themes can be identified. First, these 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). Second, they provide prescriptive sequential steps through which a company should go in order to implement changes (Vakola et al., 2000). Such discrete linear approaches to change have been challenged.

Lindsay et al. (2003), for example, contend that BPR represents a ‘repackaging’ of traditional techniques, and tend to be very mechanistic in nature. Further, the authors argue that even though attempts to soften such techniques were made, the models still represent positivistic approaches that are inappropriate to shape and structure human activity. Thus, the literature fails to address the complexity and the non-linear nature of much of the work carried out in organisations. It also assumes that humans

are rational decision makers cooperating 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 who usually have differing values, needs and goals, which leads to frequent conflict. This 'rough and tumble' of organisational life is generally not considered within the BPR literature. Therefore, there is a real need to inject a change dimension to the implementation of PDP models which considers change at individual, group and organisational levels (Makin et al., 1996; Stickland, 1998). Therefore, taking a change management perspective, the following research question is proposed:

- How do construction project teams implement process models (to meet context specific needs)?

### 2.3. Knowledge (or technology) transfer perspective

'Implementation content' refers to the transfer of the knowledge embedded in a process model from the model developers to its users. This knowledge transfer dimension provides an additional perspective on the various nuances of implementation.

To 'move' technology (i.e. a process model) within an organisation involves two main actions: transmission (sending or presenting knowledge to a user) and absorption (understanding and interpretation) by the user (Davenport and Prusak, 1998). In this way, users will be able to appropriately apply the knowledge to

manage the particular project in hand. As a result, model users can identify benefits (and problems) from the process model's use at organisational, project and individual levels. They also need to believe that the model can effectively help management, i.e. there should be a low degree of conjecture on the part of the developers on the model's utility (Szulansky, 1999).

Furthermore, the re-utilisation of the routines expressed in a process model through the different company's projects can be analysed as a replication issue (Nelson and Winter, 1982; Winter and Szulansky, 2000). This is important because model use is envisaged not only in one project, but in all company projects to allow consistency. Therefore, problems on the replication of organisational routines and on the opportunity to transfer (Szulanski, 1999) could be used to understand issues that might occur during implementation. In this way, a further research question is posed:

- Which factors affect the transfer and replication of PDP models knowledge content?

### 2.4. Discussion

The process management literature provides valuable insights into the benefits and possible outcomes from applying process models in practice. However, the focus has usually been on the process model design, leaving implementation as a marginal issue.

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 an operational level. Much of the change management literature present prescriptive models, which generally do not consider that change should be managed as a continuous event within organisations. Empirical results suggested that the use of such frameworks has led to outcomes that do not seem to be successful. There is a need, therefore, to appropriately link implementation to the organisational context and to people issues.

The technology transfer literature offers a complementary perspective by looking at the transfer of information within and across implementation steps. It also provides a framework to identify potential problems. However, problems related to transferring the knowledge content of the model throughout the organisation and between different projects have not been adequately addressed in the literature.

Based on this literature synthesis, we propose that the knowledge on process models implementation is characterised by a lack of clear direction. Several gaps in the understanding of process model implementation in construction are identified. Such gaps, and the proposed questions for this research, are set out in Figure 1. Whilst our understanding of process model implementation remains patchy, companies will continue to have difficulties in realising the espoused benefits of using process models.

FIGURE 1 HERE

## 3. RESEARCH METHOD

This research used a qualitative approach to inductively and holistically understand human experience in the context specific settings of the case study firms. As pointed out by Silverman (1998:3), a "*particular strength of qualitative research … is its ability to focus on actual practice in situ, looking at how organisations are routinely enacted*". Thus, the implementation process was analysed with an emphasis on the meanings, facts and words as seen by the participant members in order to reach a broader understanding of the phenomena.

Within this context, a case study approach was used for the purpose of learning about process models being developed within companies and understanding implementation within these contexts. In this research, theoretical sampling was applied (Yin, 1994), and four studies developed, one manufacturing and three construction companies, therefore focus on large companies sets out the domain of the findings.

Case study Company A is a telecommunications firm and was selected because it uses a well-established high-level PDP. Also, it has used different models to manage NPD for more than ten years; therefore it provided rich evidence of successful implementation over a period of time. Company B is a major contractor in the UK, and it was selected because it has designed and attempted to implement a process model. Company C is a contractor and was selected as it had finished designing a model, and was about to implement it. Finally, Company D is a large UK contractor

and had a design management process model being developed as part of a company wide improvement programme, providing an opportunity for the researcher to examine the design and implementation of a model in real time.

Multiple sources of evidence were used to allow triangulation of data. Evidence was collected through (a) semi-structured interviews, tape recorded and verbatim transcribed generating a detailed report on process model design, implementation strategies and factors perceived to have affected implementation (2 at Company A, with the projects developer and process manager; 1 at Company B with the business services manager; 1 at Company C with a managing consultant; and 4 at Company D with two design managers, a process manager and a project manager); (b) participation in diverse meetings and workshops; and (c) documentary evidence, including descriptions of the process models.

Data analysis was developed with the aid of content analysis (using QSR NVivo software). Content analysis was originally developed to investigate problems in which the content of communication serves as the basis of inference (Holsti, 1969). It is a '*research technique for making replicable and valid inferences from data to their context'* (Krippendorff 1980:21).

Interviewees' accounts on the interviews transcriptions were analysed with the aid of a coding scheme to discern fundamental categories of thinking. For each firm, qualitative responses were combined into narratives describing implementation in its context. By tracing the implementation process from the perspective of the responsible for it in each firm, a 'story' about each case was constructed (Eisenhardt,

1991). These stories formed the intra-case analysis, providing company specific insights into the research questions. Cross-case analysis was based on the search for patterns within the implementation stories and in the factors affecting implementation (Campbell, 1975). The listing of similarities and differences between companies assisted in the search for patterns.

In interpretative research, validity concerns whether the researcher has gained full access to knowledge and meanings of respondents (Remenyi et al., 1998). 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 this way, the story telling approach used to describe case study results 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*'.

The use of multiple sources of evidence and multiple informants allowed 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).

## 4. KEY ESEARCH RESULTS

The following section presents narratives briefly describing triggers (i.e. why the company decided to invest in the design of process models), the implementation content (i.e. the nature of the intended benefits from the process model to the company), the implementation process (i.e. the strategy and steps undertaken to design and implement the model), and the main outcomes (i.e. success or failure).

### 4.1. Case study A

the implementation triggers at Company A focused on avoiding the occurrence of problems such as variability between different development efforts and high risks. The company expected to achieve a ‘best practice’ process enabling better communications, shorter lead times and better meeting client requirements in a timely and cost effective manner.

The first model designed by the company described 5 processes in 3 levels of detail. The company then decided to describe it using the IDEF0 approach. The new model had very detailed activity descriptions, and was considered complex by company members. As a result, it was redesigned into a holistic process with reviews defined at the end of each stage.

The implementation was only successful when the model was sufficiently simple and flexible to be considered applicable by users. The IDEF0 model was difficult to use and inflexible due to the excessive amount of detail. Furthermore, there was an initial belief that the model should be used as an overall plan for the process (as generally proposed in the literature), and as such its use was to be mandatory. However, it was

realised this was ineffective as: (a) it generated resistance to change; and (b) the model became bureaucratic, hindering creativity: *'it takes out the ability of people to find out the best way of developing a project'* (process manager).

Company A realised that models provided value only if it was approached as a framework, through which scenarios, opportunities and threats for the project in hand can be discussed. Thus, a shift occurred in the model role, which moved from a hard, 'plan' perspective to a softer, 'learning' perspective, providing room for reflection and innovation. Appropriate control and formality was still maintained in the process through the adoption of phase reviews, as evidenced through the following interview extract:

'*the process model should not be too detailed as this would undermine its adoption… the project manager has to be very persistent and has to have good persuasive interpersonal skills*' (projects developer).

The implementation strategy focused on people issues, e.g. clearly demonstrating benefits at the organisational, project and individual levels. Factors affecting implementation related to resistance to change, motivation, engagement, commitment, clearly defining benefits, training and leadership.

Therefore, the design and implementation of process models was not a one-off activity but rather a process of continuous change and improvement. The successful use of the model was directly related to the content and level of detail of the process

description and the formulation of a non prescriptive implementation strategy, which focused on involving people to achieve buy-in and commitment.

### 4.2. Case study B

Company B presents different process improvement initiatives focusing on specific business streams. The process model considered here was to support an alliance between Company B and one of its major clients. The main triggers for the model design was to provide support for the alliance, improve communications, avoid rework, manage knowledge and lessons learnt between projects, enable process control, and make good practice available to deliver projects on time and to costs.

However, implementation outcomes were unsuccessful mainly due to cultural differences between the two companies and resistance to change: *'different cultures need to be pulled together for this to work, and the different cultures are not varying'* (business services manager, responsible for the model design).

Poor definition of benefits for users, the lack of involvement of users during the model design, the perception of the managers that they would lose 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 implementation barriers.

*'it doesn't work because what we've got is the people at middle management … 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, so we are in an environment of mistrust…'* (business services manager).

The model's knowledge content also restrained its use. The model could not be applied throughout the company as it was specific to the alliance projects, and it had not been validated. Also, the model was approached as a planning and control tool to link design and construction planning, but the operationalisation of this link was not clarified.

No strategy was formulated to support the model's use. Steps taken to design the model included identification of problems, process analysis, model design and definition of procedures. Finally, factors affecting implementation negatively and positively were tacitly identified by the company, but not systematically described or acted upon. These barriers focus mainly on people issues and on having a clear implementation strategy.

**4.3 Case study C**

The main implementation triggers at Company C were to provide support for partnering between four companies, with a focus on improving process management by defining process activities and reviews. These reviews were to focus on planning and proactive process and financial control.

The evaluation of the model content brought to light model credibility shortcomings, i.e. it was not possible to assess if the model users believed it helped management (therefore there were acceptability problems), and the role of the process model was not agreed with top management or with the future model users. These represented barriers to the adoption of the model at the project context:

*'(the problem) 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'* (managing consultant).

Great emphasis was given to determining the steps for the process model design, but this was done without any regard to its actual implementation. Furthermore, the model was to be published in the company intranet and its use mandated. As it happened in Company B, it appears that there was a belief that publishing the model and mandating its use would be sufficient for successful implementation. Finally, the factors potentially affecting implementation were related to people issues, i.e. resistance to change, training and demonstrating benefits.

### 4.4 Case study D

A company wide improvement initiative was going on during the case study, and a Design Management process model (DM) was an integrated part of it. The main implementation triggers were to achieve consistency in all projects (i.e. successful

financial outputs) by 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 should also support skills development for design managers:

*'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'*( process manager).

Implementation was unsuccessful mainly due to divergent perspectives about design management principles and about the process model itself by the top management, regional managers and design managers. Poor definition of benefits for the model users, lack of involvement of users in the model design, inappropriate definition of the implementation strategy and general mistrust were identified:

*'It was written by … people 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... So it didn't really reflects true practices, or what actually happens, that's the problem'* (design manager).

The knowledge content of the process model also restrained its use. Difficulties were identified with regards to the model content, considered complex by users due to excessive detail, which generated difficulties in adapting it to the project level. The model was found not applicable to different business areas of the company (e.g. civil

engineering). Also, the model lacked clarity with regards to the links between design management, bid management and the main project phases.

The steps identified for 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. However, due to the problems noted above, the undertaking of a pilot implementation was unsuccessful.

Finally, factors affecting implementation were not systematically identified nor acted upon by top management. These included communication problems, implementation strategy, use of information technology and people issues. Furthermore, communications between the model designers and other users was non existent. The source of information used to design the model was not perceived as reliable by the design manager who was charged with piloting the model and, thus, both the model designer and a future user lacked motivation to implement.

## 4.5 Discussion

### *Implementation triggers and outcomes*

The triggers for implementation were remarkably consistent across the case study companies, and were consistent with the espoused benefits of using process models

found in the literature. In all cases it was possible to identify benefits for the organisation as a whole, for the PDP and for the final client. It is possible to state that all companies had an emphasis on control and rational decision making to 'force' a causal correlation between having a process model and PDP improvement.

Nonetheless, each company had slightly different explanations for the use of process models. Table 1 summarises the primary and secondary focuses of the process model design and implementation across the case study firms.

TABLE 1 HERE

All the companies devised 'to-be' models describing tools for improved process management. All the maps set out to represent the process through a set of phases describing activities, functions, reviews and deliverables, and present a hierarchy of levels of detail, e.g. whole process view, activity and task levels. The models investigated propose some redesign of the sequencing of activities, but no attempts were made to introduce concurrent engineering concepts i.e. overlapping design stages to reduce lead time (e.g. Sobek et al., 1999)

The implementation outcomes were unsuccessful apart from the out-of-industry study. Therefore, the espoused benefits of process model implementation where not achieved in the construction companies despite considerable time and effort they invested in the process modelling.

***Implementation process***

Company A's implementation strategy was holistic in nature, and considered interactions between different sub-systems (including internal business units and external market pressures) and thus addressed organisational change issues. Training was not approached as the sole mechanism for change. Change was initiated by the model users' involvement in designing specific models for each business areas. This strategy led to an increased learning and commitment to the model use. Finally, the implementation strategy considered that the basis for all change reside in changing behavioural patterns. This was evidenced by the importance given to motivation and by clearly articulating and demonstrating benefits for the model users.

Conversely, in the construction case study companies, insufficient consideration was given to the change needed at the individual level, and it was not possible to identify explicit mechanisms for creating and sustaining motivation.

Therefore, the principles of classic or scientific – rational school of organisational management 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 implementation initiatives analysed. Change is therefore planned at an operational level, but without the appropriate understanding of the reality of the operational activities.

***Implementation content***

If new knowledge embedded in a model 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. These research findings demonstrate that construction companies intuitively identified such factors. However, these were not explicitly addressed or managed. The research findings also suggest that in the out-of-industry case, the factors were adequately identified and managed as part of an explicit strategy. This has supported the continuity of implementation, and has provided the company with information that helped to direct the model (re)design and use when needed.

The factors that contribute to the transmission, absorption and use of PDP models, identified in this research were grouped as follows: (a) effective communications**,** providing appropriate exchanges of tacit and explicit knowledge; (b) appropriate implementation strategy formulation and execution, considering the need for participation in model design**;** (c) information technology to enable the model use as the means to make knowledge available and support the transfer of explicit knowledge; (d) people issues**,** supporting buy-in, motivation, commitment leadership and training; and finally (e) influences from the organisational and project context in terms of creating the right environment for knowledge transfers.

Difficulties on the transmission and absorption of the PDP model content were classified accordingly to the measures of stickiness (Szulansky, 1999), 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 clarified 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.

## 5. CONCLUSIONS

### 5.1. Limitations

In the course of this research a number of issues have not been addressed, which reflect the inevitable complexity and diversity of issues involved in the implementation of process models. Therefore, there are a number of 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 were 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.

Finally, the initial research idea was to analyse polar opposite types, i.e. successful and unsuccessful implementation cases. However, there were no identified successful implementation cases in construction companies. Nevertheless, it is believed that the findings from the unsuccessful cases provided sufficiently rich information to allow the proposition of recommendations for successful future implementations. Further research could address these issues, i.e. investigating PDP implementation in small and medium enterprises, and examining successful implementation cases.

### 5.2. Contributions to theory

The rationale for generic models has developed under a traditional project management control perspective, which considers that work should be planned completely before starting. 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. 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 monitor milestones).

However, the low level of implementation success brings the validity of this overall approach into question. Findings from this research stress that process models have failed to provide product development 'centralised planning and monitoring' in construction. Also, a misinterpretation occurred in which the model was understood as being a tool to control people as opposed to improve the process. This is a major barrier, as it generates widespread cultural concerns with regards to the company objectives in impinging process models.

Also, the out-of-industry case indicated that implementation could only be successful when a 'softer' approach was taken. Model usefulness was closely related to the role of the model, approached as a learning framework providing room for reflection and innovation by autonomous stakeholders. 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.

### 5.3. Implications for practice

Key recommendations on implementation have been based on the need to consider implementation from the perspective of aligning an emergent project level strategy to an intended organisational strategy implementation (see Minzberg and Waters, 1985). 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. The key principles are posed as follows.

- **Global strategy, local activity**

The design *and* implementation of PDP models should align the overall directions formulated at the organisational level and the project level emergent strategy. Two main issues are necessary for this. First, a 'bottom-up' approach needs to be set for the 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. Therefore, a soft global outlook can be combined with hard local responsiveness.

- **Symbiotic model design and implementation**

The design and implementation need to be considered jointly to allow successful outcomes. Considering design and implementation in a symbiotic way makes clear the need to reach consensus about the role of the model within the company and its configuration, considering its adaptation for each project. The use of diverse strategies to transfer knowledge from the model designers to users is enforced, and both hard and soft approaches to transferring knowledge are required.

- **Learning rather than managerial 'command and control' focus**

PDP models need to be approached as frameworks to allow learning, as opposed to means of introducing hard controls over detailed activities. 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.

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, model users need to retain the capability to identify situations which require change, ensuring effectiveness and responsiveness throughout the process. This supports process innovation allowing for management autonomy at each project. It also allows the 'design' of the best possible way of managing the process by considering good practices and the structure of physical, political and cultural settings of product development action at each project context.

- **Meaningful participation and collaboration**

Successful PDP model implementation requires appropriate participation and engagement. Therefore, focus should be given to participatory decision making rather than the usual decoupling of teams designing and implementing the model. 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.

- **Relevant and holistic PDP model content**

A PDP model needs to be relevant, i.e. useful and applicable to allow its 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. Emphasis should be on the generic level; therefore time and efforts are not wasted in designing detailed 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.

- **Implementation levers**

Implementation levers were proposed based on a typology to classify factors driving, enabling and restraining implementation as presented in Table 2. 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.

First, the PDP model needs to have one agreed meaning, it should be simple, and transparently present key improvement principles. Second, the model needs to be useful and applicable, and for that the knowledge embedded in it needs 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. Motivation is also essential in keeping people interested and persistent to achieve successful implementation.

TABLE 2 HERE

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 a integrated, symbiotic way so that short learning cycles enabling successful implementation can be created.

### 5.4. Implications for policy

The main implication for funding bodies relates to the dissemination of what is considered to be '*good or best practice'*. PDP models are considered to be means to disseminate good product development practice within and across firms. However, such good practices can only be realised in reality if they are appropriately adapted to the specific firm and project context in hand, considering soft human issues. Furthermore, what is considered good practice in one environment may be found to be a 'bad practice' in a different context. Therefore, special attention should be given to the content of 'best practices' as well as to their suitability and adaptability to different contexts.

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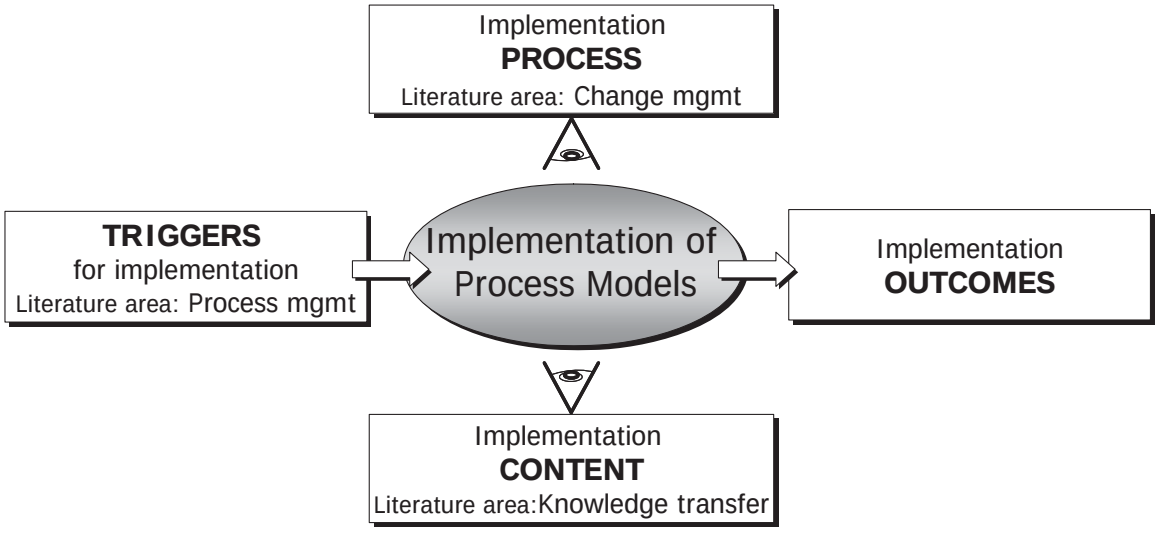


Figure 1: Framework to evaluate product development process models

Table 1: Summary of the implementation triggers

| **Focus of process model design** | **Company A** | **Company B** | **Company C** | **Company D** |
|---|---|---|---|---|
| Provide one generic best practice | ❶ | | | ❶ |
| Reduce PDP problems | ❶ | ❶ | ❶ | ❶ |
| Framework for alliance/partnering | | ❶ | ❶ | |
| Shared process understanding – training | ② | ② | ② | ② |
| Improve planning and control | ② | ❶ | ❶ | ❶ |
| Achieve consistency and success in all projects | ❶ | | | ❶ |
| Reduce risks | | ② | | ② |
| Meet client requirements | ② | ② | ② | |
| Improve communications | ② | ② | ② | ② |

Key: ❶ = primary focus; ②= secondary focus

Table 2: Factors affecting implementation and proposed implementation levers

| Recommendations | Typology of factors affecting implementation | | Implementation levers |
|---|---|---|---|
| | enablers | restrainers | |
| Relevant and holistic PDP model content | Causal ambiguity: generated due to the complexity or depth of the practice to be implemented | | • Model having one agreed, consistent meaning (consistent model role) |
| | IT enabling implementation | | |
| | Unproven knowledge: degree of conjecture on the model utility | | • Explicitly useful and applicable model |
| Meaningful participation and collaboration | Arduous relationship: ease of communications between process model developers and users | | • Easy communications |
| | Source and recipient lacks motivation: lack of motivation of the model developers and users in transferring knowledge | | • Motivate users and designers |
| | Source not perceived as reliable: model user do not perceive the model developer and the information used to build the model as reliable | | • Reliable source of information |
| | People issues | | All previous |
| Learning rather than managerial 'command and control' focus | Recipient lacks absorptive capacity: the ability of the users to apply new knowledge | | • Learning focus |
| Symbiotic model design and implementation strategy formulation | Implementation strategy (considering model design and use) | | • Appropriate model design and implementation strategy |
| Synergistic implementation strategy alignment (align intended organisational directions and emergent project strategy) | Barren organisational context: the degree to which the organisational context supports the transfers | | • Bottom-up implementation strategy formulation<br>• Fruitful organisational and project context |
| | Supportive organisational and project context | | |