IMPROVING PROJECT PERFORMANCE IN PRODUCT DEVELOPMENT

Catarina Bojesson

2015

MÄLARDALEN UNIVERSITY
SWEDEN

School of Innovation, Design and Engineering

ABSTRACT

The development of new products and processes is a crucial point of competition and due to the rapid technological development and strong international competition companies are forced to design better products faster and more efficiently. In the last two decades large companies in particular have developed increasingly sophisticated models, process descriptions, structures and routines for how to steer and manage their often large and complex projects. Processes in product development projects often contain many dependencies among both tasks and people, requiring coordination of activities and the opportunity to capture incomplete information that evolves over time. When attempting to increase project performance a strong focus has been on the efficiency of the projects, on doing things right. As a result, both in industry and within research, effectiveness, doing the right things, is given less attention. For companies to really increase their performance, effectiveness must be considered to a much greater extent.

The objective of the research presented in this thesis has been to increase the knowledge of how the performance of the project organisation in a product development context can be improved. This involves investigating factors which affects performance on different levels of the projects such as the individual working on the project, the single project, the project organisation, the company, and the business context. Data have been collected through literature studies as well as a case study divided into two parts.

The research results show that project organisations face the challenge being able to have projects running efficiently according to plan while at the same time exploring and creating new knowledge. Formalised product development processes can support the progress of projects, but there is a risk that exploratory work and innovation could suffer. This is a challenge especially in contexts characterised by uncertainty and complexity. Further, a number of areas which affect the project performance were identified, including the business context, process characteristics, project model, project characteristics, and project management. These findings have resulted in a proposed start of a framework for improving product development project performance in dynamic contexts.

ACKNOWLEDGEMENTS

PUBLICATIONS

This thesis is based on the three papers listed below. The papers are appended in full and are referred to in the text by their Roman numerals.

Paper I

Bojesson, C. & Jackson, M. (2014). *Linking development efficiency, effectiveness, and process improvements*, Proceedings of the 10th International Symposium of Tools and Methods of Competitive Engineering, May 19-23 2014, Budapest, Hungary.

Bojesson was the main author and presented the paper. Jackson participated in the writing process, reviewed and quality assured the paper.

Paper II

Bojesson, C., Jackson, M. & Strömberg, A. (2014), A. *Rethinking effectiveness: Addressing managerial paradoxes by using a process perspective on effectiveness*, Proceedings of the 21st EurOMA Conference, June 20-25 2014, Palermo, Italy.

Bojesson was the main author and presented the paper. Jackson and Strömberg reviewed and quality assured the paper.

Paper III

Bojesson, C., Backström, T. & Bjurström, E. (Accepted), *Exploring tensions between creativity and control in product development projects*, accepted for publication and presentation at the International Conference on Engineering Design (ICED15), July 27-30 2015, Milano, Italy.

Bojesson was the main author. Backström and Bjurström reviewed and quality assured the paper.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

The development of new products and processes is a focal point of competition (Wheelwright and Clark, 1992) and due to rapid technological development and strong international competition companies are forced to design better products faster and more efficiently (Clarkson and Eckert, 2010). This tough competition is pressuring companies into trying to improve and optimise their processes. Product development processes are, however, not deterministic (Clarkson and Eckert, 2010), and hence, no single optimal process design is possible to find. Product development processes contain many dependencies among both tasks and people, requiring coordination of activities and the opportunity to capture incomplete information that evolves over time (Park and Cutkosky, 1999).

In product development, reduction of project lead times from idea-to-market is in many industries seen as a way of increasing the competitive advantage and has therefore been a prioritised challenge for many companies (Griffin, 2002, Valle and Vázquez-Bustelo, 2009, Minderhoud and Fraser, 2005). As a result of this, development efficiency has gained importance in trying to achieve increased performance and in turn lead to competitive advantage. Efficiency is in this context of improving the product development process used to describe the attempt to do what you are already doing better. When selecting improvement initiatives, measurability of the improvement area is a highly rated characteristic, because of the possibility to investigate whether the improvement initiative is successful. Organisations want to be able to measure whether they are improving, which results in efforts on areas which can be measured in e.g. time or money. This puts the focus on internal efficiency factors, whereas the external effectiveness factors are left aside due to the difficulties in measuring their evolvement. The focus when trying to improve the product development process should instead be on increasing effectiveness, doing the right things (Drucker, 1974). When limiting the focus to efficiency and trying to do only what you are already doing in a better way, the question of whether you are actually doing the right things will not be considered and efforts towards improvement might be misdirected.

Both in industry and in research, effectiveness is given less attention than efficiency. For companies to really increase their development performance, effectiveness must be considered to a much greater extent. The product development process depends on both efficiency and effectiveness in the activities performed in order to be successful (Cedergren, 2011). In order to link the project's execution to business value, it is important to understand the characteristics of the specific project. Even though the project characteristics are critically important for the effective management of projects employing new technologies, relatively little literature addresses the matter or associations between specific characteristics and the project's success (Tatikonda and Rosenthal, 2000). This is in contrast to the more fully developed empirical literature on organisational processes and techniques to carry out product development projects efficiently.

1.2 Industrial problem

Bombardier, is a global manufacturer of aeroplanes and trains. Bombardier Transportation in Sweden focuses on the development and manufacturing of trains and railway equipment and the division Propulsions & Control develops and produces propulsion and control systems for customers worldwide. The direct customer can be either Bombardier's division for complete vehicles or an external customer. For the majority of the projects, the customer is internal.

The development of trains is characterised by long lead times, requirements which are customer specific and a high amount of changes during the development process. Thus, most new projects imply new product features due to customer specific needs. Since the work on product design, production design and sourcing activities must be concurrent, changes are often hard to handle as they affect many functions in the organisation. Complexity of the projects is also caused by the dependencies between different design teams as the product consists of several components designed by different teams but with interdependencies. The many changes result in problems regarding the ability to meet project deadlines and targets, as well as affecting the overall product development efficiency.

A key characteristic of the development projects, which cause further complexity, is that the projects have a fixed delivery date and customer specific requirements, but at the same time traits of new product development projects such as technological novelty and new concepts. The project organisation uses a stage-gate process for the idea-to-launch process, but there have been problems with following the designed process and managing and controlling the project according to this. The company works continuously with improvements of the process but these improvement initiatives have not always targeted the right areas and there are difficulties in finding the solutions which will lead to increased performance.

Marmgren and Ragnarsson (2014) describe, from their view as practitioners, that large companies in particular have in the last two decades developed increasingly sophisticated models, process descriptions, structures and routines for how to steer and manage their often large and complex projects. Their understanding is that this desire to increase the efficiency of the projects through increased control in the complex projects has the opposite result most of the time.

1.3 Problem statement

As described in the background, there is often a narrow view on how to improve the performance in project organisations with a strong focus on the efficiency of the projects. The industrial problem also describes that improvement initiatives are not always targeting the right areas and that there are often difficulties in finding the solutions which will lead to increased performance.

This suggests that there is a need for an increase of innovative thinking regarding how to organise projects as well as a need for an increased understanding of how specific circumstances affect the performance of the project. As a conclusion, there seems to be a knowledge gap regarding a holistic view on project performance

which is required as well as that the factors supporting or hindering improvement must be better understood.

1.4 Research objective

The objective of this licentiate thesis is to increase the knowledge of how the project performance in a product development context can be improved. This involves investigating factors which affects performance on different levels of the projects such as the individuals working on the project, the single project, the project organisation, the company, and the business context.

In addition to the scientific contribution, the intent is also to contribute to practical improvements in industry through the development of a framework, proposed to support the work with increasing the effectiveness in product development projects.

1.5 Research questions

Based on the background and the problem statement two research questions have been formulated. One question has the focus on the factors which have impact on project performance, while the other question focuses on the area of how to improve project performance.

RQ1: What factors influence project performance?

RQ2: How can project performance be improved?

These questions have been formulated with the intention to act as a guiding support when investigating previous research and gathering empirical data which will be analysed in order to fulfill the research objective

1.6 Delimitations

This research project is limited to customer specific product development projects in a manufacturing industry context. The empirical data has been gathered through studies at one single case company. The choice of this specific case company is because of the connection the author has to the company as an industrial PhD student. The purpose of focusing on a single case company at this stage of the research is to get a deeper understanding of the problem situation.

1.7 Thesis outline

This thesis contains six chapters and three appended papers. This first chapter, Chapter 1, introduces the research by presenting the background, the problem description, the problem statement, the research objective and research questions, as well as the delimitations. Chapter 2 presents the theoretical frame of reference of the thesis and is followed by the methodology employed in the research project presented in Chapter 3. Chapter 4 summarises the research results regarding both literature essentials and empirical essentials which form the base for the analysis. Chapter 5 contains the overall discussion and presents the proposed framework. Finally, in Chapter 6 the conclusions and the suggested areas for future research are presented.

2 FRAME OF REFERENCE

The purpose of this chapter is to describe the theoretical field which is relevant for this research project by presenting an overview of previous research. The chapter is divided into three parts: Project organisation, Project performance, and Improving performance. Project organisation represents the context of the research project, whereas Project performance and Improving performance are related to the research questions. The first part, Project organisation, gives an overview of different organisational processes and characteristics of product development projects. In the Project performance part relevant concepts are described to get an understanding of what is included in performance of product development projects. The last part, Improving performance, covers areas that increase the understanding of factors vital to improvement work.

2.1 Project organisation

An organisation is a group of people united by common goals, with existing procedures or guidelines which coordinates their efforts in realising these common goals (Jacobsen and Thorsvik, 2008). Projects represent unique, complex, and time-limited processes of interaction, organisation and management, and the term project has come to describe temporary organisations. Due to the widespread use of projects in organisations today, project organisations exists because there is a need for a purposeful organisation effort and a high need of coordination in order to execute a number of activities (Söderlund, 2004).

2.1.1 ORGANISATIONAL PROCESSES

Process is a concept which originally means a prolonged course of activities resulting in the change of something. In many companies the word process is used to describe a flow of recurring activities within the organisation. The fact that a process consists of recurring activities means that the process should be able to be improved in order to increase its performance. An important distinction can be made between processes for which it is possible to predefine each activity, such as production processes, and processes for which the result of one specific activity can create many different ways of action for the next part of the process, such as development processes. A rough division of processes can be made into hard and soft processes. (Marmgren and Ragnarsson, 2001)

2.1.1.1 Hard processes

A chain of activities or events which are possible to predict and describe is called a hard process. This kind of process follows a predefined plan and is possible to control (Winter and Checkland, 2003). The start and finish are both well-defined and the way to reach the goal, including different people's actions, follows a carefully arranged schedule. With this definition many production processes can be seen as hard processes. They are possible to plan and control and are well suited for an analytical breakdown of activities (Marmgren and Ragnarsson, 2001).

Many organisations consider themselves as being part of a hard system and manage their processes according to hard systems methodology as most of the current theory

on project management is based on the ideas of hard systems thinking (Winter and Checkland, 2003), fixated on the tradition of presenting optimal solutions (Normann, 2001). Especially in dynamic contexts, most systems are instead closer to soft systems and need management methods according to that.

2.1.1.2 Soft processes

Soft processes always consist of uncertainty to some extent which also means they have elements of e.g. creativity. There is a starting point and a goal or objective, but the goal is expressed as a desired state or function rather than a defined specification. Hence, the goal will change and become clearer during the progression of the process implying that the plan must be created and revised gradually. Product development most often includes characteristics of soft processes. When searching for new technical solutions it is impossible to define the end goal at the starting point of the process. It is necessary to accept uncertainty when trying to achieve novelty and the focus must be on how to handle uncertainty instead of trying to reduce uncertainty (Marmgren and Ragnarsson, 2001). Soft processes require different management than hard processes. These processes cannot be controlled, only supported, with the focus on the social process of managing (Winter and Checkland, 2003). Development work is prone to failure if trying to streamline the work as if it was a hard process (Marmgren and Ragnarsson, 2001).

2.1.1.3 Relations between processes

Figure 1 shows a simplified, linear and sequential descriptions of the relations between the product development, production development, product realisation, the innovation process as well as the product life cycle (Säfsten et al., 2010).
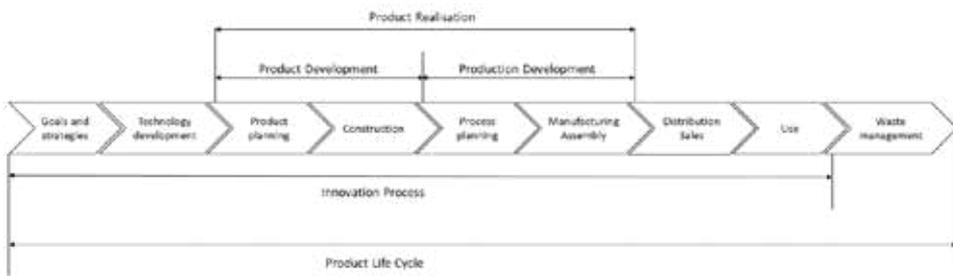
Figure 1: The relations between different processes

Although many companies use concurrent engineering with overlapping phases, this description of the processes is common as a base in the organising of innovation work (Säfsten et al., 2010).

2.1.2 PRODUCT DEVELOPMENT PROJECTS

2.1.2.1 Stage gate models

Most companies use some kind of stage-gate model for the idea-to-launch process (Cooper and Edgett, 2012). The Stage-Gate™ model is an operational and conceptual model for moving a product development project through the various stages and steps from idea to launch (Cooper, 2006). A standard Stage-Gate model is shown in Figure 2.
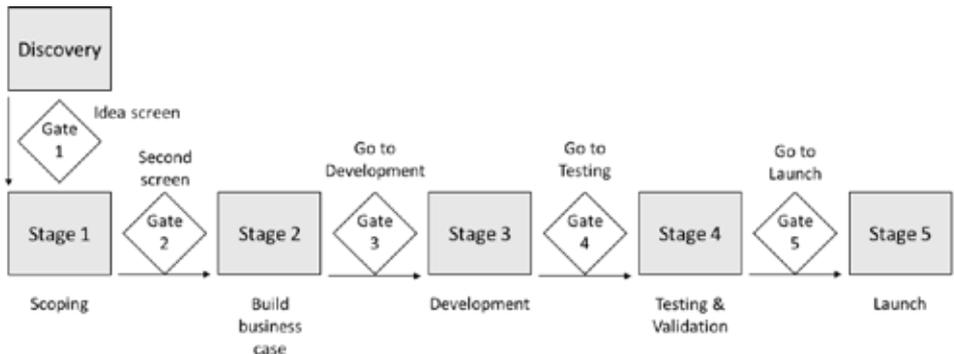
Figure 2, An overview of a typical stage gate model (Cooper, 2008).

The innovation process can be visualised as a series of stages, each comprised of a set of required or recommended best-practice activities needed to move the project forward to the next gate or decision point (Cooper, 2008).
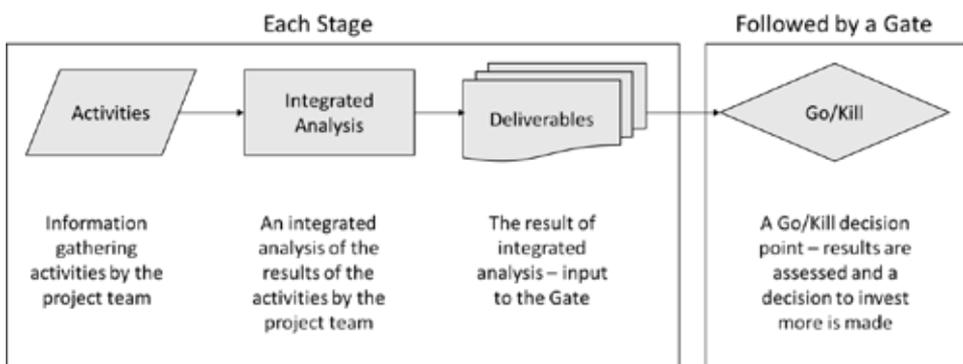
Figure 3, Stage-Gate consists of a set of stages followed by Go/Kill decision gates (Cooper, 2008).

As seen in Figure 3, in each stage the project team undertakes the work, obtains the needed information, and does the subsequent data integration and analysis, followed by gates where Go/Kill decisions are made (Cooper, 2008).

The model should be tailored to each specific company's own circumstances with built-in flexibility in their processes, however, some companies' idea-to-launch systems resemble rule books with processes full of rules, regulations and mandatory procedures regardless of the circumstances (Cooper, 2008).

2.1.2.2 Project characteristics

The process of development projects have moved from a sequential path towards an integrated path, known as concurrent engineering, in which activities overlap and all departments collaborate from the beginning of the project. Although many studies demonstrate that concurrent engineering can be a successful approach, some studies show the opposite (Valle and Vázquez-Bustelo, 2009). Minderhoud and Fraser (2005) suggest that concurrent engineering can be used to improve the efficiency of the development process, but to enhance the effectiveness of the process, iterative approaches must be used. For companies in a context with a high level of uncertainty, novelty and complexity, concurrent engineering methodology does not lead to positive results neither for development time nor for product superiority (Valle and Vázquez-Bustelo, 2009). This implies that a difficult but necessary challenge for project organisations is to have projects running efficiently according to plan but at the same time leaving room for exploration and the creation of new knowledge (Sundström and Zika-Viktorsson, 2009).

It is necessary to understand the impact specific business requirements have on the organisation and management of product development projects. In fast and dynamic markets, an important key to a capable product development process is its ability of handling uncertainty (Minderhoud and Fraser, 2005). Organisations sometimes face unexpected events or surprises that make prior plans irrelevant or incomplete in important ways (Moorman and Miner, 1998). Hence, although planning is important in development projects, following the plans and procedures strictly tends to paralyse the project members' activities when faced with unforeseen problems (Akgün et al., 2007).

2.1.2.3 Managing projects

Project management and formalised product development processes can support progress as well as development, but there is a risk that exploratory work and innovation could suffer. A greater focus on control, as opposed to flexibility, in leadership and structures, could affect creativity negatively (Sundström and Zika-Viktorsson, 2009).

As complex systems create competing processes to achieve a desired outcome, organising paradoxes arise, including e.g. tensions between routine and change (Smith and Lewis 2011). Management control systems are the formal, information-based routines and procedures that managers use to maintain or alter patterns in organisational activities (Simons 1995), while operational control refers to the process of assuring that specific tasks are carried out effectively and efficiently

(Anthony 1965). There is a stream of research stating that management control systems have a positive impact on innovation in uncertain environments, while another stream of research argues that management control systems risk undermining the motivation and creativity needed for effective performance on highly uncertain tasks (Adler and Chen 2011). By defining how to operate, as well as how not to operate, organising tensions are created such as flexible versus controlling (Smith and Lewis 2011). These tensions between e.g. control and flexibility underlie paradoxes of organising (Lewis, 2000).

The norms and demands which organisations meet are sometimes difficult or even impossible to combine since they can be contradictory or inconsistent (Brunsson and Olsen 1990). When confronted with paradoxes the natural reaction is often to attempt to resolve and rationalise them. However, in today's complex organisations, models based on linear and rational problem solving do managers a great disservice (Lewis 2000) since it has been found that linear models do not adequately represent the innovation process (Bledow et al. 2009).

2.2 Project performance

2.2.1 EFFICIENCY AND EFFECTIVENESS

Both efficiency and effectiveness are goal-oriented practices related to achieving success (Jugdev and Muller, 2005). Efficiency looks at maximising output for a given level of input (Jugdev and Muller, 2005). Effectiveness has been defined in various ways but most definitions relate to the output; the degree to which a predetermined objective is achieved (Ojanen and Tuominen, 2002), the degree to which the actual result corresponds to the aimed result (O'Donnell and Duffy, 2002, van Ree, 2002), or the extent to which customer requirements are met (Neely et al., 2005). Colloquially, efficiency is known as doing things right, and effectiveness as doing the right things. Management of any organisation requires both efficiency and effectiveness, and project organisations in particular bring these matters to the fore (Rämö, 2002).

Examples of efficiency indicators are profitability, costs, and cycle time. Effectiveness measures are, however, not that tangible or as easy to grasp as the efficiency metrics. Furthermore, they take a longer time to determine. As a result, effectiveness becomes a secondary area of focus (Jugdev and Muller, 2005).

In the context of development process performance, efficiency is used to describe the attempt to do what you are already doing better, but the focus when trying to increase the performance of the processes should instead be on increasing the effectiveness, doing the right things (Drucker, 1974). Even though this was advocated by Drucker (1974) more than 40 years ago and it is well accepted that project management is applied on projects to achieve both efficiency and effectiveness, the emphasis in the literature has been on efficiency (Jugdev and Muller, 2005). Consequently, there is a need for an increased focus on how to achieve effectiveness in product development projects.

According to Cedergren (2011), the product development process depends on both efficiency and effectiveness in the activities performed in order to be successful. The management of development projects often has a strategic value when a clear connection is made between how efficiently and effectively a project is executed and how the project's products and services provide business value (Jugdev and Muller, 2005). Product development has often been seen as a purely technical process, but nowadays the connection to the business aspects has increasingly become more important (Cedergren, 2011). If the link to the business value is missing, project management will be perceived only as providing operational value and not strategic value. The difficulties in finding tangible effectiveness measures are putting the main focus on efficiency and are further establishing the risk of project management being perceived only as an operational asset (Jugdev and Muller, 2005). The service dominant logic which involves changing the perspective from selling a product to creating value for the customer suggests shifting the perspective from efficiency to effectiveness (Vargo and Lusch, 2008).

In order to link the project's execution to business value, it is important to understand the characteristics of the specific project. Even though the project characteristics are critically important for the effective management of projects employing new technologies, relatively little literature addresses the matter or the associations between specific characteristics and the success of the projects (Tatikonda and Rosenthal, 2000). This is in contrast to the more fully developed empirical literature on organisational processes and techniques to carry out product development projects efficiently. For companies to really increase their performance, effectiveness must be considered to a much higher extent.

2.2.1.1 Process effectiveness

Brown and Eisenhardt (1995) discuss factors affecting the success of product development and highlight the distinction between process performance and product effectiveness. They define process performance as the speed and productivity of product development. Evolving from this, several suggested descriptions of process performance or process effectiveness have been developed (Moorman and Miner, 1998, Hoegl and Gemuenden, 2001, Valle and Avella, 2003, Minderhoud and Fraser, 2005, Akgün et al., 2007, de Weerd-Nederhof et al., 2008, Kekäle et al., 2010). These proposed definitions, which can be found in paper II, include a great variety of factors in different combinations. However, no generally accepted definition exists yet.

Regarding product development processes in dynamic environments two of these proposed definitions seem more suitable. de Weerd-Nederhof et al. (2008) propose that process performance or process effectiveness not only comprise speed and productivity, but also process flexibility, referring to the ability to gather and rapidly respond to new knowledge as a project evolves. Similarly, Kekäle et al. (2010) discuss process effectiveness as reflected in speed and productivity, but with the additional dimension of the need for a dynamic fit between the product development system and its context. The process should be capable of adjusting to new information as the project evolves in order to be considered effective.

2.2.2 PROACTIVE AND REACTIVE APPROACHES

Previous research has suggested that early problem-solving is directly linked to development performance (Thomke and Fujimoto, 2000) and that effective projects are characterised by a structure that minimises changes of the product design once the execution stage has begun (Cooper, 1990). However, in very innovative projects, one generalisation is that the entire development process is a process of constantly performing changes (Fricke et al., 2000). Users of the products are themselves part of a larger dynamic context which changes as other parts of the context are engaged in problem-solving as well, making it a source of instability (Thomke, 1997). In development projects where customers have limited opportunities to formulate requirements at the early phases of the projects, the customer perspective has to rely primarily on the engineers' well-founded understanding of customers and their situation (Sundström and Zika-Viktorsson, 2009). The later a change is performed, the higher the resulting consequences are: mainly increases in cost and schedule delays (Fricke et al., 2000). When operating in uncertain and unstable environments, companies will find that increasing design flexibility and adjusting the respective development strategy accordingly will provide a significant competitive advantage over other firms (Thomke, 1997).

When managing projects, original project plans and project goals, need to be changed to address the dynamics caused by uncertainty. A study of 448 projects showed that the positive total effect of the quality of planning is almost completely outweighed by the negative effect of goal changes (Thomke and Fujimoto, 2000). This indicates that planning is necessary but not a sufficient condition for project success. Project planning is an ongoing task and therefore it is subject to changes. An approach of freezing the design specifications early in the project would reduce the overall number of design changes, but would also include the risk of foregoing significant design improvement opportunities from using information that becomes available further along in the development process, such as changes in customer preferences (Thomke, 1997). With an early freeze of requirements, the risk of being locked into an unfavorable solution increases, suggesting that rigorous processes can harm the performance of novel products by resulting in an inferior design (Marion, 2009).

In product development there is a need for both individuals and teams to be creative and innovative which requires them to be curious and to strive for newness. At the same time, these individuals and teams are supposed to produce efficiently and must focus on existing routines and close their minds to new ideas which will cause interruptions (Bledow et al., 2009). Hence, successful product development requires managing tensions through the combination of building innovative capacity and achieving efficient execution (Lewis et al., 2002). Creativity is needed when tasks are uncertain, while formal controls are needed when tasks are complex and interdependent (Adler and Chen, 2011). Tasks are often both uncertain, and complex and interdependent, requiring the ability of creativity and control simultaneously. Much organisation theory argues that organisations confront a trade-off between efficiency and flexibility, as efficiency requires bureaucracy and that bureaucracy impedes flexibility. Some researchers have, however, challenged

this theory, arguing that there is a possibility to attain both superior efficiency and superior flexibility (Adler et al., 1999). Even though the development of detailed implementation plans are important for innovation, equally as important is the flexibility to be responsive to unforeseen events which might lead to giving up on previous plans and cause fundamental changes to the course of action (Bledow et al., 2009). Lewis et al. (2002) found that product development may require managers to use emergent and planned activities concurrently and be able to go back and forth between management styles as changes in project uncertainty occur, as well as make trade-offs between competing demands. According to Gilson et al. (2005) creative and standard practices do not have to be mutually exclusive but can complement one another to benefit both performance and customer satisfaction. There may be a need for teams to be skilled in using both creative and standardised approaches, as well as learning to adapt their work styles as circumstances call for (Gilson et al., 2005), requiring managers to adapt different behaviours according to contextual demands, the progress of the project, and the needs of individual employees (Bledow et al., 2009). However, even though management styles are of great importance to innovation outcomes, little empirical research has directly examined how conflicting demands could be effectively managed and self-regulated (Anderson et al., 2014, Bledow et al., 2009).

2.3 Improving performance

In dynamic contexts, sustained organisational performance depends on the organisation's ability to change through innovation but at the same time continue to perform in the short term (Smith and Tushman, 2005). There has been an increasing focus on the development of tools for the industrial design process, with the hope that these tools will make the process more efficient and effective (Marion, 2009). A common practice at manufacturing companies is continuous improvements of the product development processes. The process should be designed to help the project team with the progress of the project. Instead, too many processes, implemented with the best of intentions, appear to create bureaucracy and include a lot of non-value-added work (Cooper and Edgett, 2012). Creativity is, however, an important dimension of innovation and the interactions between people in product development work (Sundström and Zika-Viktorsson, 2009).

Management innovation represents a certain form of organisational change where novelty is introduced in an established organisation. The rational perspective on management innovation builds on the idea that management innovations are introduced by individuals with the goals of making their organisations work more effectively (Birkinshaw et al., 2008). When organisations are streamlining how work is performed and encouraging their employees to standardise work practices but at the same time encourage teams to be creative, teams are faced with a dilemma as to whether standardised work practices or creativity will enhance their overall effectiveness (Gilson et al., 2005). Further, it is important to understand the fundamental psychological and social principles involved in innovation and the ability to adapt methods to contextual demands (Bledow et al., 2009).

Institutional change refers to both the emergence of new institutions and the decline and disappearance of old ones (Edquist, 1997). Similarly, administrative reforms refers to deliberate changes to an organisation's form, structures, ways of working or ideologies, with the purpose of improving its behaviour and results (Brunsson and Olsen, 1990). Hargrave and Van de Ven (2006) define institutional change as a difference in form, quality, or state over time in an institution. If the change is novel or an unprecedented departure from the past, then it can be considered an institutional innovation. There is much more resistance to institutional and organisational change than to technological change. The classical force behind institutional change is, however, technological change (Edquist, 1997).

It has been found that inconsistencies between core capabilities and innovation demands can lead to more use of existing strengths, resulting in missed opportunities for creative breakthroughs. Further, trying to increase the simplicity in environments characterised by growing complexity prevents organisations from recognising the need for potentially disruptive change (Lewis, 2000). Some of the major capabilities of modern institutions come from their effectiveness in substituting rule-bound behaviour for individually autonomous behaviour (March and Olsen, 2004).

Institutions may have both supporting and retarding effects on innovation, but a specific institutional set-up can neither permanently support nor retard innovation (Edquist, 1997). When faced with uncertainty and a need for a change, there is a risk of managers mimicking successful organisations by adopting their systems and processes (Simons, 1995) not suitable for their own organisation. A similar risk is that when using external change agents e.g. consultants, they might see their role as stimulating managers to adopt an existing or fashionable practice, rather than to create a new one (Birkinshaw et al., 2008). Bledow et al. (2009) propose that "one-best-way" recommendations for organisational innovation which do not take into account the specific situation and context of a given organisation are misguided and may even do more harm than add value.

The introduction of something new creates ambiguity and uncertainty for the individuals in an organisation (Birkinshaw et al., 2008). Individuals demonstrate a strong preference for consistency in their attitudes and beliefs and between their cognition and their actions. This may result in a mindless maintained commitment to previous behaviours in order to enable consistency between the past and the future, and these commitments become reinforced by organisational structures which support consistency (Smith and Lewis, 2011). Even though formal rules may change overnight as a result of management decisions, the constraints on behaviour embodied in customs, traditions, and codes of conducts typically change incrementally (North, 1990).

In paper III a number of different mechanisms are presented which affect the individuals in the organisation, making them express opinions and take actions which contradict their actual experiences:

- *The desire to do right*, *the desire to achieve and contribute,* and *the desire to create* (Simons, 1995).
- *The logic of appropriateness* (March and Olsen, 2004).
- *Bounded rationality* (Simon, 1991, Gigerenzer, 2008, Weick, 2001).
- *Measurement systems* (Robson, 2004, Cravens et al., 2010).
- *Cognitive frames* (Smith and Tushman, 2005, Lewis, 2000, Simons, 1995).

2.4 Literature essentials

The review of the literature presented in this chapter led to a number of important conclusions which are relevant for this research project. Below, the summary and conclusions of the literature essentials are presented.

2.4.1 PROJECT ORGANISATION

- It is important to understand the characteristics of the organisational processes in order to find the most suitable way of managing and supporting them (Marmgren and Ragnarsson, 2001).
- Stage-gate models should be tailored to fit the circumstance of the specific company. Some companies' processes include rules, regulations and mandatory procedures regardless of the circumstances. (Cooper, 2008)
- Studies show differing results as to whether concurrent engineering can be a successful approach for development projects or not (Valle and Vázquez-Bustelo, 2009, Minderhoud and Fraser, 2005).
- Project organisations face the challenge of having projects running efficiently according to plan but at the same time leaving room for exploration and creation of new knowledge (Sundström and Zika-Viktorsson, 2009).
- The impact that specific business requirements have on the management of development processes must be well understood (Minderhoud and Fraser, 2005, Moorman and Miner, 1998, Akgün et al., 2007).
- Formalised product development processes can support progress as well as development, but there is a risk that exploratory work and innovation could suffer (Sundström and Zika-Viktorsson, 2009).
- Complex systems can include competing processes in achieving the desired outcome, resulting in organising paradoxes, such as tensions between control and flexibility (Smith and Lewis, 2011). When confronted with paradoxes the natural reaction is often to attempt to resolve and rationalise them (Lewis, 2000).

2.4.2 PROJECT PERFORMANCE

- The success of product development projects depends on both efficiency and effectiveness (Cedergren, 2011), but effectiveness has become a secondary area of focus (Jugdev and Muller, 2005).
- The main focus on efficiency measures have led to project management being perceived as an operational asset, and not a strategic one (Jugdev and Muller, 2005).

- The characteristics of the specific project are critically important for the effective management of projects employing new technologies; however, relatively little literature addresses the matter (Tatikonda and Rosenthal, 2000).
- There is no generally accepted definition of process effectiveness but several different suggestions. The definitions which seem most suitable in this context include speed, productivity, and process flexibility as the ability to rapidly respond to new knowledge as a project evolves (de Weerd-Nederhof et al., 2008) or the need for a dynamic fit between the product development system and its context (Kekäle et al., 2010).
- Previous research has suggested that development performance is achieved through early problem solving (Thomke and Fujimoto, 2000) and a structure that minimises changes of the product design once the execution stage has begun (Cooper, 1990). However, in uncertain and unstable environments, companies will find that increasing design flexibility and adjusting the respective development strategy accordingly will provide a significant competitive advantage over other firms (Thomke, 1997).
- Project plans and project goals need to be changed to address the dynamics caused by uncertainty (Thomke and Fujimoto, 2000). An early freeze of requirements increases the risk of being locked into an unfavourable solution (Marion, 2009).
- Tasks are often both uncertain, and complex and interdependent, requiring the ability of creativity and control simultaneously (Adler and Chen, 2011). Product development may require managers to use emergent and planned activities concurrently and be able to go back and forth between management styles as changes in project uncertainty occur, as well as to make trade-offs between competing demands (Lewis et al., 2002).
- Little empirical research has directly examined how conflicting demands could be effectively managed and self-regulated (Anderson et al., 2014, Bledow et al., 2009).

2.4.3 IMPROVING PERFORMANCE
- In dynamic contexts, organisations must be able to change through innovation but at the same time continue to perform in the short term to sustain organisational performance (Smith and Tushman, 2005).
- The project process should be designed to help the project team with the progress of the project (Cooper and Edgett, 2012).
- Management innovations are introduced by individuals with the goals of making their organisations work more effectively (Birkinshaw et al., 2008).
- When organisations are streamlining how work is performed and encouraging their employees to standardise work practices but at the same time encouraging teams to be creative, teams are faced with a dilemma as to whether standardised work practices or creativity will enhance their overall effectiveness (Gilson et al., 2005).

- There is much more resistance to institutional and organisational change than to technological change (Edquist, 1997).
- Inconsistencies between core capabilities and innovation demands can lead to more use of existing strengths, resulting in missed opportunities for creative breakthroughs (Lewis, 2000).
- Trying to increase the simplicity in environments characterised by growing complexity prevents organisations from recognising the need for potentially disruptive change (Lewis, 2000).
- "One-best-way" recommendations for organisational innovation which do not take into account the specific situation and context of a given organisation are misguided and may even do more harm than add value (Bledow et al., 2009).
- The introduction of something new creates ambiguity and uncertainty for the individuals in an organisation. Individuals demonstrate a strong preference for consistency (Birkinshaw et al., 2008).

3 METHODOLOGY

3.1 Scientific approach

There are different views on how and when to use different methodologies. As these different views make different assumptions about what is being studied, and approach it in different ways, it is important for a researcher to explain the view or approach adopted (Arbnor and Bjerke, 1994).

Based on different ways of viewing and approaching the reality, a division into three different approaches can be made.

- Analytical approach
- Systems approach
- Actors approach

An important difference between these approaches is to what extent the development of knowledge is explanatory or hermeneutic (Arbnor and Bjerke, 1994). According to *positivism*, the truth is found through strictly following a method independent of the content or context of what is being studied (Kvale and Torhell, 1997). In positivism it is assumed that the reality exists and is observable, stable, and measurable (Merriam, 2009). The influence of the researcher should be eliminated or minimised (Kvale and Torhell, 1997). This is a way of developing only explanatory knowledge (Arbnor and Bjerke, 1994). In contrast, in *hermeneutics* or *interpretivism* the understanding and interpretation of the object or phenomenon studied is central. The objectivity of the researcher is seen as non-existent, and therefore not worth pursuing (Arbnor and Bjerke, 1994). Interpretive research is where qualitative research is most often located. This orientation assumes that reality is socially constructed and hence there is no single, observable, reality (Merriam, 2009).

- The perception of reality in the *analytical approach* is that the whole is the sum of its parts, where each part can be given a quantitative value. The focus is on simplicity and each causal factor should be able to be defined and isolated. The knowledge created is independent of individuals, and because of that objectivity the reality can be explained (Holme et al., 1997, Arbnor and Bjerke, 1994)
- The *systems approach* adopts the view that reality is arranged in such a way that the whole deviates from the sum of its parts. Hence the relationships between the parts are of utmost importance as they have either positive or negative effects. The knowledge developed based on the systems approach is according to these conditions system dependent. Individuals can be part of a system, but their behaviour follows systemic principles, meaning that they can be explained, and sometimes understood and interpreted, in terms of

systemic properties. Hence the systems approach explains or understands the parts based on the properties of the whole (Arbnor and Bjerke, 1994).

- In contrast to the systems approach, in the *actors approach* the whole is explained based on the properties of the parts. But similar to the systems approach, great importance is put on the relationships and interactions between the parts, but with a greater emphasis on creativity and unpredictability (Holme et al., 1997). The actors approach has no interest in explaining, but in understanding social entities. This is based on the individual actors and focuses on the significance and meaning that different actors put into their actions and the surrounding environment. The reality is seen as a social construction where wholes as well as parts are ambiguous and can be re-interpreted (Arbnor and Bjerke, 1994).

The overall topic of this research project is improvement of product development projects in a manufaturing context. The scope includes connections with the production system and the external environment resulting in a complex system to be investigated. This motivates that the systems approach is suitable. The performance of product development projects is also affected by the people in the organisation as well as the customer, motivating that the actors approach also should be considered within the research project.

3.2 Research design

3.2.1 RESEARCH METHODOLOGY

3.2.1.1 Design Research Methodology

The design of the research process has been inspired by the Design Research Methodology framework by Blessing and Chakrabarti (2009). The framework consists of four main stages: (1) Research Clarification (RC), (2) Descriptive Study I (DS-I), (3) Prescriptive Study (PS), and (4) Descriptive Study II (DS-II). In the RC stage the purpose is to find some evidence or indications that support the assumptions made, in order to formulate a realistic research goal. This is done mainly by searching literature and based on the findings an initial description of the existing situation is developed, and possibly also a description of the desired situation. Having a clear goal and focus, the DS-I stage aims at elaborating the initial description of the existing situation to make the description detailed enough to determine which factors should be addressed. This is done though further review of the literature as well as the gathering of empirical data. In the PS stage the increased understanding of the existing situation is used to correct and elaborate on the initial description of the desired situation. A support to reach the desired situation can now be developed. The purpose of the DS-II stage is to investigate the impact of the support and its ability to realise the desired situation. This is achieved through empirical studies. This research project has so far covered the first two stages: Research Clarification and Descriptive Study I.

3.2.2 DEDUCTION AND INDUCTION

Deductive reasoning is linked with the hypothesis testing approach to research and is mainly associated with the positivist approach. Inductive reasoning is associated with the hypothesis generating approach to research. Hypotheses are generated from the analysis of the data collected through field work and observations (Williamson, 2002). Qualitative research is considered an inductive process since researchers gather data to build concepts, hypotheses, or theories rather than deductively testing hypotheses (Merriam, 2009).

However, Carlile and Christensen (2004) describes the process of building theory in management research as the deductive process and the inductive process as two sides of the same pyramid, shown in Figure 4. When an anomaly is identified, meaning an outcome for which a theory cannot account, an opportunity to improve theory occurs.
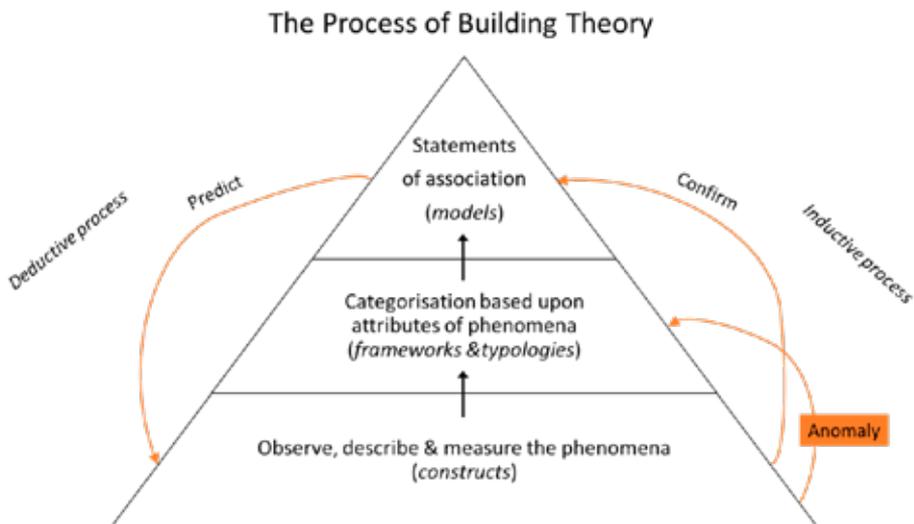
Figure 4: The process of Building Theory (Carlile and Christensen, 2004)

This description of theory building is a suitable generic map to represent the research strategy when moving between studying previous research and real cases as an industrial PhD student.

3.2.3 DATA ANALYSIS TECHNIQUES

Data collection and analysis is a simultaneous activity in qualitative research. Analysis begins with the first interview, observation or document read as insights, hunches, and tentative hypotheses will emerge. This will direct the next phase of data collection (Merriam, 2009).

Miles and Huberman (1994) define analysis as consisting of three concurrent flows of activity: data reduction, data display, and conclusion drawing and verification. Data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming the data. Data reduction should occur continuously throughout the qualitative oriented project. Data can for example be reduced and transformed through selection, summary or paraphrase. Generically, a display is an organised, compressed assembly of information that permits conclusion drawing and action. In the sense of data displays, this could include matrices, graphs, charts, and networks. Conclusion drawing begins already at the start of data collection. The qualitative analyst begins to decide what things mean by noting regularities, patterns, explanations, possible configurations, causal flows, and propositions. Conclusions must also be verified. The meanings emerging from the data have to be tested for their plausibility and sturdiness, that is, their validity.

Qualitative data analysis is primarily inductive and comparative. The overall process of data analysis begins by identifying segments in the data set that are responsive to the research questions (Merriam, 2009).

3.3 Data collection

Data have been collected through literature studies as well as a case study divided into two parts. The purpose of studying previous research through literature searches has been to identify, locate, synthesise, and analyse the conceptual literature about the specific problems of the research topic (Williamson, 2002). The literature studies have made it possible to place the research project in a theoretical context and to support the identification of the problem to research and show that there is a gap in previous research which needs to be filled (Ridley, 2008). The advantage of the case study has been the opportunity of developing an understanding of social phenomena in their natural setting (Williamson, 2002). According to Yin (2009), 'a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident' (p. 17).

Table 1 presents an overview of the research design and the relationship between research stages, research questions, studies, data collection techniques, the unit of analysis, and where the results from each study have been presented.

Table 1: Overview of the research design

DRM research stage	RQ	Study	Data collection	Unit of analysis	Presentation of results
RC	1 and 2	I	Literature	Product development project execution	Paper I

RC/DS-I	1 and 2	A	Interviews, document analysis, observations	Product development projects	Paper I and III
DS-I	1 and 2	II	Literature	Process effectiveness	Paper II
DS-I	1 and 2	B	Questionnaire	Product development projects	Paper II and III
DS-I	1 and 2	III	Literature	Institutional and organisational behaviour	Paper III

3.3.1 PROCESS OF STUDIES

As described in 3.2.2, the research process has been an iterative process between studying theory and collecting empirical data. Figure 5 shows a timeline with the process of studies.
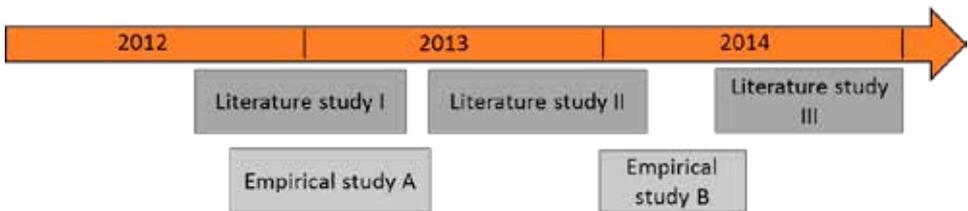
Figure 5: The process of studies

3.3.1.1 Literature study I

The purpose of literature study I was to provide a context for the research project in order to define the area of study and specify the research topic. This was to be achieved by identifying key terms, definitions and relevant terminology, through studying theory related to the efficient execution of product development projects in a manufacturing context. The databases and search engines included in the study were Discovery, Google Scholar, ScienceDirect, Scopus, and Web of Science. The searches included different combinations of the words "product development", "late changes" or "late design changes", "flexible process" or "process flexibility", "project planning", "uncertainty", and "manufacturing".

This study was the base for the theoretical background in paper I *Linking development efficiency, effectiveness, and process improvement*.

3.3.1.2 Empirical Study A

Empirical study A was conducted through qualitative and investigative methods in order to analyse product development performance in a manufacturing industry context. A case study was performed at Bombardier Transportation in accordance with the guidelines identified by Yin (2009).

The empirical study at Bombardier Transportation was performed in an explorative manner, as exploratory interviews can be very useful in the early stages of most research projects (Williamson, 2002). The purpose of the study was to investigate and analyse the current state of the product development process. The empirical study focused on methods and models used by the project team during the product development work and the introduction of products into the manufacturing system.

As an industrial PhD student at the case company and project member of an internal improvement project aiming at reducing the lead time of the product development process, I was able to assume the role as a participant observer. Within the internal improvement project, ten different on-going product development projects where studied through document analysis as well as through semi-structured interviews with project managers and engineering project managers. The interviews were planned and conducted in collaboration with the project manager of the lead time reduction project. A certain set of questions involving the project process, planning, deviations and problems were developed in advance, but the interviews remained open-ended, assuming a conversational manner.

The document analysis included internal documents describing the project model for product development projects as well as work descriptions for different stages of the projects. When there is a need to gain understanding of the official policies of the setting being studied, this can often be achieved by reading the documents which are produced by the organisation or setting (Williamson, 2002). Using multiple sources of evidence develops the advantage of converging lines of inquiry. Any case study finding or conclusion is likely to be more convincing and accurate if it is based on several sources of information (Yin, 2009).

The results from the interviews showed that similar problems occur in most projects. Based on these patterns of similarities, in order to structure and enable an analysis of the case study results, a grouping of the results into five different areas was made: Requirements Management, Project Planning, Preconditions, Organisation, and Changes.

To enhance the validity of the results all the respondents were able to read and comment on a summary of their own interview. The interviews conducted were semi-structured, and as a result some topics were only mentioned by one or a few respondents, making it difficult to evaluate its importance generally. The results from the interviews were discussed in a workshop with the steering committee of the lead time reduction project where the most commonly mentioned problem areas were prioritised according to expected improvement potential. As this was an exploratory study of a single case company as well as the first theoretical study performed within this research project further research is needed in order to validate

the results and draw general conclusions. However, the insights from the study resulted in a research clarification which narrowed the focus for the following studies.

The results from the study were presented in paper I, *Linking development efficiency, effectiveness, and process improvements*.

3.3.1.3 Literature study II
The purpose of literature study II was to develop an increased understanding of the concept of effectiveness regarding definitions, assessment of effectiveness, and the connection to process efficiency, inspired by the results from study I and study A. The unit of analysis was therefore the concept of effectiveness. Based on which databases and search engines that had previously proven most suitable for this area of research, the databases and search engines used in the study were Discovery, Google Scholar, and Scopus. The search words included, in different combinations, were "development efficiency", "effectiveness", "context" or "context based" or "context specific", "manufacturing", "customer", "product development", "assess", and "process improvement". Based on the article *Product Development: Past Research, Present Findings, and Future Directions* (Brown and Eisenhardt, 1995), an additional search of publications referring to this article including "process effectiveness" was made.

The results from this study in combination with the findings from study A inspired the choice of design for study B.

The theoretical background in paper II, *Rethinking effectiveness: Addressing managerial paradoxes by using a process perspective on effectiveness*, was mainly based on the results from this study.

3.3.1.4 Empirical Study B
In this study the empirical data were gathered through a questionnaire survey. The questionnaire was designed based on the results from empirical study A and literature study II. The purpose of the questionnaire was verification or falsification of indications and assumptions made based on the results of study A, and therefore carried out at the same company. The results from study II supported the development of the themes and statements used in the survey. The questionnaire consisted of 40 statements with fixed answer alternatives, and with the opportunity to add thoughts and comments at the end. The statements were formulated based mainly on information from the previous interview study, different project types and project management methods (Marmgren and Ragnarsson, 2001), and hard and soft systems thinking (Checkland, 2000, Checkland and Poulter, 2010). The questionnaire covered the areas of *project characteristics*, *project process and plan*, *uncertainty and complexity*, *managing the project*, and *project success*.

The questionnaire was specifically directed to project managers at the case company and the study was performed during one of the project managers' regular meetings, meaning that everyone answered the questionnaire at the same time, with the opportunity to ask questions to the researcher in case of any uncertainties. Out of

the 18 project managers who attended the meeting, 17 chose to participate in the study. The time span that the respondents had worked as project managers at this company, at the time of the study, varied between six months and 15 years, with the average time being 5.8 years.

The results from the questionnaire showed differing opinions among the respondents as well as contradictory opinions for individuals. The results for the statements were, therefore, analysed in relation to one another in order to highlight paradoxes.

The results from the study were presented in paper II, *Rethinking effectiveness: Addressing managerial paradoxes by using a process perspective on effectiveness*.

3.3.1.5 Literature study III

After analysing the empirical findings from study B in relation to the theory based on study II a need for further analysis of the empirical findings was discovered, based on a different frame of reference, which was the motivation behind this literature study.

The purpose of literature study III was to investigate previous research in institutional theory in connection with organisational tensions and conflicts, as well as how institutions affect actions of the individuals within the organisation and the underlying mechanisms behind it. The literature studied included literature provided within a course, Innovation Management in a Manufacturing Context, literature based on advice from senior researchers with a knowledge of the field, as well as additional literature searches in Discovery. The searches included different combinations of the words "institutional change", "institutional innovation", "institutional behaviour", "innovation", "control", "tension", and "paradox".

The results from this study formed the theoretical base for Paper III, *Exploring tensions between creativity and control in product development projects*.

3.4 Quality of research

A common approach to evaluate the quality of the research is to investigate the validity and reliability of the research results. In this sub-chapter the strategies which can be employed to increase the validity and reliability of the research are presented and discussed in relation to the empirical studies. Further, how the role of the researcher might affect the quality of the research is also discussed.

3.4.1 VALIDITY

Validity is concerned with accuracy, the extent to which a research instrument measures what it is designed to measure (Williamson, 2002). Validity is often discussed as being divided into internal validity and external validity.

3.4.1.1 Internal validity

Internal validity deals with the question of how research findings match reality (Merriam, 2009) and refers to the confidence that observed results are attributable to the impact of the independent variable, and not caused by unknown factors (Williamson, 2002). The strategies a qualitative researcher can use to increase

internal validity include *triangulation*, *respondent validation*, *adequate engagement in data collection*, *reflexivity*, and *peer examination* (Merriam, 2009). To increase the internal validity of the studies, each of these strategies has been applied to some extent.

Triangulation can be achieved by using multiple methods, multiple sources of data, multiple investigators, or multiple theories to confirm the emerging findings (Merriam, 2009). In study A multiple methods were used, including interviews, document analysis, and observations. Further, multiple investigators were involved in the data collection and analysis. However, the other investigator had a practitioner's perspective and the data collection and analysis were not performed separately but in collaboration. By following up study A with study B, increased internal validity was achieved as multiple sources of data could be compared.

Respondent validation means soliciting feedback on the emerging findings from people who have been interviewed which can eliminate the risk of misinterpretations (Merriam, 2009). The interview respondents were given the opportunity to review and give feedback on the results from study A.

It is difficult to define when *adequate engagement in data collection* has been achieved but can be explained as the point when the data and emerging findings feel saturated (Merriam, 2009). In study A the decision not to continue with further interviews was made when very little new information was surfacing and the same things were being mentioned over and over again.

Reflexivity is the process of reflecting critically on the self as a researcher, meaning that researchers need to explain their biases, dispositions, and assumptions (Merriam, 2009). In study A an approach of transparency when making assumptions in the analysis was used. These assumptions were later included in study B to be able to confirmed or falsified.

Peer examination is a strategy of letting other researchers, either external or colleagues, review the results (Merriam, 2009). Peer examination has been performed continuously throughout the research project mainly by supervisors and colleagues, but also external researchers who have reviewed the publications and have attended presentations at conferences.

3.4.1.2 External validity
External validity refers to the generalisability of research findings, meaning the extent to which they can be generalised to other populations, settings or treatments (Williamson, 2002). A condition for external validity is that the results are considered as being internally valid (Merriam, 2009). Single-case studies have been criticised as offering a poor basis for generalising. However, case studies rely on analytical generalisation, where the investigator is striving to generalise a particular set of results to some broader theory (Yin, 2009). The possibilities of generalisation in qualitative studies, as well as the usefulness of it, are areas of discussion with differing opinions. The most common understanding of generalisability in qualitative studies is reader or user generalisability, meaning that it is up to the

person reading or using the study to decide whether the findings apply to his or her particular situation (Merriam, 2009).

There are strategies which can be used to enhance the possibilities of the results being transferable to another situation. *Rich, thick description* refers to a highly descriptive, detailed presentation of the setting and particularly the findings of a study. *Maximum variation* refers to giving careful attention to selecting the study sample, either in the selection of sites or the participants being interviewed to achieve variation or diversity. (Merriam, 2009)

To ensure transparency of the results from the studies the approach of descriptive and detailed presentation of both the setting and the findings has been used. Regarding variation and diversity the purpose of the single case study has primarily been to get a deeper understanding of a phenomenon and at this stage not to generalise by comparing several different cases. However, by relating the empirical findings to previous research studied in the literature it is put in a wider context.

3.4.2 RELIABILITY

Reliability is concerned with obtaining consistent, stable research results with replication (Williamson, 2002). Human behaviour is, however, not static. Replication of a qualitative study will therefore not yield the same results. Reliability in qualitative research relates instead to whether the results are consistent and dependable, meaning that given the data collected, the results make sense (Merriam, 2009).

Strategies which can be used to ensure reliability in qualitative research are *triangulation*, *peer examination*, *investigator's position*, and *the audit trail* (Merriam, 2009). The first three strategies, which have already been discussed in the part regarding internal validity, were used in the studies to increase the reliability.

3.4.3 ROLE OF THE RESEARCHER

It is unavoidable to acknowledge that the research is influenced by the context in which it is carried out. This research project is one of the projects within the research school Innofacture. The focus area for the projects within Innofacture is innovative production development which has consequently influenced the choice of scope for this project. Further, the connection to the company Bombardier as an industrial PhD student has inspired the problem being investigated and has influenced the choice of case company.

At Mälardalen University and the research profile of Innovation and Product Realisation, the research area is Innovation and Design. Both regarding improvement work and product development, a central aspect is innovation. This research project involves an innovative way of looking at the effectiveness of product development projects in order to find a better suited project process design. Consequently, this research project is closely related to both innovation and design.

4 RESULTS AND ANALYSIS

This chapter follows the same structure as Chapter 2, Frame of reference, divided into the parts (1) Project organisation, (2) Project performance, and (3) Improving performance. Each section presents empirical essentials from study A and study B, and ends with a short analysis based on these empirical essentials and the literature essentials presented in Chapter 2. As discussed in chapter 3.4.1.2, the purpose is to achieve analytical generalisation by generalising the empirical results to a broader theory.

4.1 Project organisation

4.1.1 LITERATURE ESSENTIALS

The literature essentials related to the following empirical essentials are presented in chapter 2.4.1. These literature essentials covers the areas of organisational processes, stage-gate models, concurrent engineering, challenges for project organisations, the impact of business requirements on the management of development processes, formalised product development processes, and organising paradoxes as a result of competing processes in complex systems.

4.1.2 EMPIRICAL ESSENTIALS

4.1.2.1 Study A: Interview study

The stage-gate model currently used for the projects is considered well designed but many projects have had difficulties in following the process stringently and the general impression among project managers is that the project organisation has not been optimal. The holistic perspective seems to be missing with low visibility of task status between different functions in the projects and deviations from the process being made without establishing them firmly with every function involved.

As many of the required resources are shared between several ongoing projects and there is a high demand on resources there have been difficulties in getting the right resources when needed, resulting in projects quite often having to work with fewer resources than requested. Most projects, especially longer ones, are also faced with a high turnover of key persons which results in inefficient work when new people need to get introduced into the project. The fact that the project group is global has been a factor for complexity, especially in the cases where the main responsibility for certain functions has been moved between different sites, causing uncertainty and deficiencies in communication. In general, a lot of administration and coordination of activities has been required due to organisational complexity.

A lack of project portfolio thinking is suggested as affecting resource issues as well as resulting in the fact that problems are solved more than once, since similar problems occur in several projects, instead of making use of lessons learned from previous projects.

The preconditions for a project are not always accurate since the project characteristics and conditions under which the project is sold do not reflect the current reality. Both the time and financing required can be underestimated due to

either lack of knowledge internally or lack of knowledge on the customer's part. Design specifications can change due to several reasons, one being that the design concept used is not mature enough, forcing the project group to go back to an older and well-established design concept. External factors that will lead to preconditions being changed come mainly from the end customer.

Since the work on product design, production design and sourcing activities must be concurrent, changes are often difficult to handle as they affect many functions in the organisation. Activities which have been planned to be performed concurrently often have interdependencies. When changes are made in the development of the product, changes might also have to be made in the production planning, such as the development of assembly instructions. The numerous changes result in problems regarding the ability to meet project deadlines and targets, as well as affecting the overall product development efficiency. Complexity of the projects is also caused by the dependencies between different design teams as the product consists of several components designed by different teams but with interdependencies. A key characteristic of the development projects, which cause further complexity, is that the projects have a fixed delivery date and customer specific requirements, but at the same time traits of new product development projects such as technological novelty and new concepts.

4.1.2.2 Study B: Questionnaire study
The complexity of the product development projects is considered high with a great amount of dependencies between the different parts of the project. There is a risk, sometimes a high risk, of prerequisites of the project changing while the project is on-going. A close collaboration between the different departments involved in the project is required and the conditions for collaboration can be considered satisfactory but with room for improvement. Many of the phases in the projects are dependent on knowledge gained in earlier phases. Generally it seems as though the project members all have well defined roles, tasks and responsibilities.

To support collaboration between the different parts of the project is seen as the project manager's primary task. The project manager is also required to have deep insight into what is happening in all parts of the project, and to make sure that the project plan is followed efficiently. Project members are required to possess more information and knowledge than what is required for just solving their own tasks; however, the majority of the project managers do not think that all the project members have this information and knowledge. They are of the opinion that only a few people have a complete overview and understanding of the entire project.

There is not a coherent view on the uncertainty and complexity of the projects and opinions are divided regarding the following aspects:

- Whether the level of uncertainty and complexity is high throughout the entire project.
- Whether uncertainty and complexity makes it difficult to follow the project plan.

- Whether it is difficult to manage the projects according to the predetermined process.
- Whether the project plan should be followed strictly.
- Whether the projects should be managed even more strictly and in accordance with the predetermined project process and plan.

Even though the majority of the project managers state that a large amount of unexpected events occur during the projects and believe that these unexpected events easily affect several parts of the organisation, only about half of them feel that there must be a high level of preparedness for events in the external environment. This stands in contrast to the impression that changes in the projects caused by unexpected events are difficult to handle, which is also contradictory to the suggestion that there are already established methods for dealing with unexpected events.

It is generally agreed upon that the expected outcome of a project is clear at the start of the project, yet it is also subject to change as the project progresses. The opinions of the project managers are, however, divided regarding several aspects:

- Whether the projects' progression is possible to predict or not.
- Whether the activities and events of the projects can be predetermined.
- Whether it is possible to follow the initial project plan throughout the whole project.
- Whether a new plan is always created if the initial plan cannot be followed.

One of the most experienced project managers commented that there are many processes to be followed throughout the project and these processes are not always compatible.

4.1.3 ANALYSIS
As many projects have difficulties with following the project process according to the predefined project model, this suggests that it is not tailored to fit the circumstances of this specific company, or at least not possible to tailor to fit specific projects.

The approach of concurrent engineering also seems problematic due to the increased complexity it results in. The purpose of using concurrent engineering is to increase the efficiency by executing tasks in parallel instead of sequentially. When there are dependencies between different parts of the project, this approach might instead lead to work having to be redone, resulting in inefficiency both regarding time and the use of resources.

The difficulty to handle unexpected events points towards a lack of understanding of how to manage and support the process. Differing opinions indicate that the characteristics of the organisational processes and the impact of business requirements are not well understood.

There seems to be a conflict between the ability to have projects running efficiently and simultaneously leaving room for exploration and creation of knowledge. That

fact that many of the phases in the projects are dependent on knowledge gained in earlier phases shows a need for flexibility and knowledge creation, which might suffer due to a strong focus on efficiency through a formalised process.

The tasks mentioned as the primary ones for project managers are to support collaboration between the different parts of the project, to have deep insight into what is happening in all parts of the project, and to make sure that the project plan is followed efficiently. This seems well suited with the challenge that the project organisations face of having projects running efficiently according to plan but at the same time leaving room for exploration and creation of new knowledge.

4.2 Project performance

4.2.1 LITERATURE ESSENTIALS

The literature essentials related to the following empirical essentials are presented in chapter 2.4.2. These literature essentials covers the areas of efficiency and effectiveness, the consequences of focusing mainly on efficiency measures, the importance of considering specific project characteristics, process effectiveness, early problem-solving, design flexibility, project plans, requirement freeze, the consequences of task uncertainty and task complexity on project management, and management of conflicting demands.

4.2.2 EMPIRICAL ESSENTIALS

4.2.2.1 Study A: Interview study

Requirements management is a problematic area as requirements are supposed to be frozen early in the project but the project group often has to work based on assumptions and with a moving target for a substantial amount of time since requirements are subject to change. Issues with the requirement specification not always being clear and mutually understood by all involved parties at the start of a project has resulted in many changes of the design in the later stages of the project. Another challenge is that the requirement freeze gate is placed earlier in time than the corresponding gate at the customer developing the complete vehicle system. Opinions are divided regarding whether the requirements freeze gate should be stricter and that the project members must work harder in identifying the correct requirements at the start of the project, or if the focus should be on reactive methods instead due to the fact that the likelihood of requirements being subject to change is so high.

The initial project plan is based on the assumption that the information available at the beginning of the project is correct and complete. Due to changes that occur in the projects there is often a need for continuous re-planning which is, however, not performed in an adequate way most of the time. A compressed time plan in combination with a fixed delivery date for the product can result in activities supposed to be executed sequentially being re-planned to be executed in parallel. The knowledge that a large number of changes will most likely occur creates a lack of commitment to the project plan, which can result in an unrealistic time plan from the start.

When the holistic perspective of the impact of a change is missing it makes it difficult for project management to explain, for example to the customer, how it will affect the time plan of the project. Design changes are mainly caused by late customer changes, misinterpretation of requirements or requirement assumptions not being accurate. Some needs for changes are not discovered until engineering and manufacturing meet in the pre-series production. Generally, there is a lack of reactive methods to handle changes. The focus for managing changes has been proactive methods such as early requirement freeze, in order to minimise the amount of changes. Since the focus on proactive methods has not been successful to the extent required, questions regarding reactive methods have surfaced as this not is integrated in the current process design. The focus when trying to manage and minimise project changes has primarily been on the changes which are results of design changes. Other reasons for changes in the project which must be considered are the ones related to legal restrictions, organisational processes and the production.

4.2.2.2 Study B: Questionnaire study

Opinions differ regarding what determines whether a product development project has been successful or not. The three factors, *the end product*, *how well the project plan could be followed through the whole project*, and *how well unexpected events could be handled*, were suggested as areas defining the success of a project. Table 1 shows how the answers of the project managers were divided for each of the factors.

Table 2: What defines the success of a product development project?

	Strongly agree	Agree to a large extent	Agree to a fairly small extent	Do not agree at all
The end product	3	5	9	0
How well the project plan could be followed	2	7	5	3
How well unexpected events could be handled	3	12	2	0

Only three of the project managers strongly agreed or agreed to a large extent that all of the three areas mattered when defining whether a project had been successful.

4.2.3 ANALYSIS

As the results in study A show that the company has a proactive approach to the projects with early problem-solving and a requirement freeze placed early in the projects. For problems that are possible to solve early, doing so will result in both high efficiency and effectiveness. However, when focusing solely on a proactive approach in uncertain environments it will most likely result in neither high efficiency nor effectiveness. Further, it is remarkable that the opinions regarding what defines the success of a product development project are so scattered.

It seems as the project managers are aware of the fact that there is a mismatch between the design of the project process and the project characteristics since they

have to create the project plan based on the assumption that the information available at the beginning of the project is correct and complete but at the same time know that a large number of changes most likely will occur.

The company is acting in a dynamic environment, requiring flexibility regarding project plans and requirements. As tasks can be both uncertain and complex, there is a need for both control and creativity in the management of the projects.

That little empirical research has directly examined how conflicting demands could be effectively managed and self-regulated, even though the need has been identified in the literature, shows a gap in the research which needs to filled.

4.3 Improving performance

4.3.1 LITERATURE ESSENTIALS
The literature essentials related to the following empirical essentials are presented in chapter 2.4.3. These literature essentials covers the areas of the need to change through innovation but at the same time continue to perform in the short term to sustain organisational performance, project process design, management innovations, the dilemma between standardised work practices and creativity, resitance to institutional and organisational change, missed opportunities for creative breakthroughs as a result of focusing on existing strengths, "one-best-way" recommendations for organisational innovation, and individuals' strong preference for consistency.

4.3.2 EMPIRICAL ESSENTIALS

4.3.2.1 Study A: Interview study
On a general level lead time reduction has been a prioritised area for improvement. Specific suggestions for how to improve include: visual planning, a planning tool for the engineering work, a full-time planner in the projects, a closer presence from the engineering department after the handover to operations, and enhanced project portfolio thinking to handle the issue of shared resources. At the workshop with the steering committee of the lead time reduction project the discussion focused on which areas had the most potential to positively affect the reduction of the lead time. The area which was seen, by far, as the one with the most potential to be able to contribute to a reduced lead time was requirements management. If customer requirements were clear and complete at the start of the project, it would reduce the problems radically according to the steering committee.

The strict focus on executing the tasks that are required for passing through the next upcoming gate has resulted in a lack of focus on other issues which need to be resolved for the project to progress, causing imbalance in prioritisation regarding where efforts are put in and where efforts are needed when looking at the long-term perspective. Another characteristic which has been stated as essential when implementing improvements is measurability, as the ability to measure the improvement is considered very important.

The focus for managing changes has been proactive methods such as early requirement freeze, in order to minimise the amount of changes. Since this has not been successful to the extent required, questions regarding reactive methods have arisen. Methods for managing later changes in the project have been requested as this is not integrated in the current process design. The focus when trying to manage and minimise project changes has primarily been on the changes which are results of design changes. Other reasons for changes in the project which must be considered are the ones related to legal restrictions, organisational processes and the production.

The projects, as they progress with many changes during the whole lifecycle, have generated a problem-solving attitude in the organisation and especially among project managers. Expectations from the customer to start the product design work early in the project as well as the feeling among project members of having to progress with the work from the very start has contributed to the attitude of starting the work based on assumptions. This attitude itself is not seen as negative, but might not fit with the process as it is currently designed.

Improvement projects often come to a stop when reaching the implementation phase. There is not a lack of ideas and initiatives for improvements, but a difficulty in actually implementing suggested solutions.

Two different consulting projects have resulted in the solution that front-loading the projects would lead to significant improvements. The organisation has put a lot of effort into the attempt of front-loading the projects and working with proactive methods in order to try to reduce changes, and have accepted this solution without really questioning whether or not this actually is a suitable approach for this organisation. This has raised the question if the company is actually the kind organisation that can use the strategy of front-loading in a successful way.

4.3.2.2 Study B: Questionnaire study
There is not a coherent view on the uncertainty and complexity of the projects. Further, there are divided opinions among project managers as well as inconsistent views for individuals; the process is difficult to follow, but it should be followed even more strictly.

Even though 10 of the respondents think it is difficult to manage the projects according to the predetermined process, 12 of the project managers feel that the project plan should be followed strictly, and 13 are of the opinion that the projects should be managed even more strictly and in accordance with the predetermined project process and plan.

Project members are required to possess more information and knowledge than what is required for just solving their own tasks, however, the majority of the project managers do not think that all project members have this information and knowledge. They are of the opinion that only a few people have a complete overview and understanding of the whole project.

4.3.3 ANALYSIS

The desire to have customer requirements clear and complete at the start of the project does not seem realistic and might result in a focus on an area which is difficult, or even impossible, to improve. It seems like an attempt to increase the simplicity in an environment characterised by complexity, which will prevent the organisation from recognising the need for potentially disruptive change. Further, it could be misguiding to rely on "one-best-way" recommendations from external agents such as consultants.

Even though project managers find it difficult to manage the projects according to the predetermined process, they propose that it should be even more strictly followed than it currently is. This suggests a preference for standardising the work as well as a preference for consistency. The problems with the implementation of improvement initiatives could be connected to the resistance to organisational change and that the need for change has not been recognised.

The strict focus on executing the tasks that are required for passing through the next upcoming gate has resulted in a lack of focus on other issues which need to be resolved, suggesting that the project process is not designed in a way which supports the project team in the progress of the project. This priority of executing the tasks relevant for passing through the gates will most likely have a negative impact on the time efficiency if there are other activities and tasks which need to be dealt with regarding the actual progress of the project. Further, this has caused an imbalance in prioritisation regarding where efforts are put in and where efforts are needed when looking at the long-term perspective. That the ability to measure improvements is prioritised creates a short-term perspective on improvement work.

5 TOWARDS A FRAMEWORK FOR IMPROVING PROJECT PERFORMANCE

The overall objective of this thesis has been to increase the knowledge of how the performance of the projects in a product development context can be improved, which involves investigating factors that affect performance on different levels of the projects such as the individual working on the project, the single project, the project organisation, the company, and the business context. It has previously been stated that product development performance depends on both efficiency and effectiveness. To be able to make the product development process effective, it must be understood what "the right things to do" actually are.

In paper I it is discussed that companies must use processes and methods designed for their specific needs. Further, decisions regarding process design and methods must be aligned with the strategy, based on the contextual setting of the company and external factors affecting it. This is to prevent the risk of using methods that might hinder the progress of the project instead of supporting it. The need to emphasise the importance of the effectiveness of the process is discussed in paper II. In a business context affected by uncertainty and complexity, the relationship between the development process and the external environment is of great importance. When uncertainty and complexity is high throughout most parts of the project it implies a constant interface or relationship between the project process and the external environment. The degree of uncertainty and complexity determines the difficulty in managing the relationship between the process and the environment. It is suggested that a process design which allows for reactive problem-solving, creativity and flexibility when facing unexpected events will result in high process effectiveness. Questions regarding why organisations try to design and manage the projects in a way which is contradictory to the characteristics of the environment they are acting in are discussed in paper III. Even when there seems to be a need for a reactive approach with room for flexibility and creativity, an approach with a focus on proactive methods and activities for the project model and project management is advocated. Strong institutions reinforce this behaviour.

In accordance with the discussions in the three papers, areas and aspects which have influence on project performance and the work with improving project performance where identified in the analysis presented in this thesis, based on the studied literature and the results from the empirical studies. Five prioritised areas to consider in order to improve project performance in product development are suggested: business context, process characteristics, project model, project characteristics, and project management. Further, there are barriers to change which need to be overcome in order to achieve institutional and organisational change, which is critical to understand when working towards improving the project performance.

These five areas, as well as the barriers to change, will be discussed in the first part of this chapter based on the literature and empirical results previously presented in the thesis. With the background of this synthesis a framework has been developed.

The framework is intended to be used as a support in the process of improving performance and is presented and described the second part of this chapter.

5.1 Discussion

5.1.1 BUSINESS CONTEXT

The results from the studies show that the external environment and business context of an organisation must be considered to achieve capable product development projects. An important aspect to consider is that users of the products are themselves part of a larger dynamic context which changes as other parts of the context are engaged in problem-solving as well, making it a source of instability (Thomke, 1997). External factors that will lead to preconditions being changed mainly come from the end customer. Product development has often been seen as a purely technical process, but nowadays the connection to the business aspects has increasingly become more important (Cedergren, 2011), such as understanding the customer's context and adapting accordingly. As proposed by Kekäle et al. (2010), for a process to be effective there must be a dynamic fit between the product development system and its context. In order to accomplish this, the context must therefore be well understood.

The ability to handle uncertainty is especially important in fast and dynamic markets (Minderhoud and Fraser, 2005) as organisations will face unexpected events (Moorman and Miner, 1998). If an organisation acting in a dynamic environment does not acknowledge the presence of uncertainty and complexity and tries to increase the simplicity, it might prevent the organisation from recognising the need for potentially disruptive change (Lewis, 2000). The approach of freezing the design specifications early in the project in order to reduce the overall number of design changes (Thomke, 1997) is most likely both an efficient and effective approach in stable environments where it is possible to have the correct requirements at the start of the project. However, in more dynamic environments this approach will include the risk of foregoing significant design improvement opportunities further along in the development process through new information, such as changes in customer preferences (Thomke, 1997). It is therefore surprising that the project managers at the case company do not agree that there must be high level of preparedness for events in the external environment as it stands in contrast with the impression that unexpected events are difficult to handle. Since it has been identified that the projects are affected by unexpected events, it does not seem realistic to believe that it is possible to make customer requirements available, clear and complete at the start of the project. This is an attempt to increase simplicity which could lead to misdirected improvement initiatives. It is more likely that increasing design flexibility and adjusting the respective development strategy accordingly will provide a significant competitive advantage over other firms (Thomke, 1997).

5.1.2 PROCESS CHARACTERISTICS

It is important to distinguish between processes with different characteristics as they will require different management methods. A fixation on the tradition of presenting optimal solutions (Normann, 2001), as well as the fact that much of the theory on

project management has been based on the ideas of hard systems thinking (Winter and Checkland, 2003) has resulted in many organisations considering themselves as being part of a hard system and managing their processes according to hard systems methodology.

Product development most often includes characteristics of soft processes where it is necessary to accept uncertainty when trying to achieve novelty and the focus must be on how to handle uncertainty instead of trying to reduce uncertainty (Marmgren and Ragnarsson, 2001). An example from the case company is that there is a risk, sometimes a high risk, of prerequisites of the project changing while the project is ongoing. It must also be considered that different projects as well as different parts of a project must be managed according to the current needs as the process characteristics might vary between the stages.

Since the work on product design, production design and sourcing activities must be concurrent, changes are often difficult to handle as they affect many functions in the organisation. Valle and Vázquez-Bustelo (2009) suggest that for companies in a context with a high level of uncertainty, novelty and complexity, concurrent engineering methodology does not lead to positive results for neither development time nor product superiority . A strong focus on making the process efficient may actually lead to the opposite result as development work is prone to failure if trying to streamline the work as if it was a hard process (Marmgren and Ragnarsson, 2001). It is therefore of great importance to understand the characteristics of the processes, as well as differences between processes and stages, in order to adapt appropriately.

5.1.3 PROJECT MODEL

The purpose of using a project model, such as the stage gate model, for the product development process is to help the project team with the progress of the project. It should therefore be tailored to each specific company's own circumstances (Cooper, 2008). If this is not done, the project process will most likely not be effective. Hence, the project model is another important aspect to consider in order to achieve high performing projects.

The case company has a proactive approach to the projects with early problem-solving and a requirement freeze placed early in the projects. For problems that are possible to solve early, doing so will most likely result in both high efficiency and effectiveness. However, when using a proactive approach in uncertain environments it will probably result in neither high efficiency nor effectiveness. The design of the project model at the case company has led to a strict focus on executing the tasks that are required for passing through the next upcoming gate with a lack of focus on other issues which need to be resolved. The tasks which need to be executed in order to efficiently progress by passing through a gate are apparently not always the same as the ones which need to be resolved for the actual progression of the work, once again pointing towards an ineffective design of the process which does not take in to account the actual circumstances of the specific project. Many processes, even though implemented with the best of intentions, appear to create bureaucracy and include much non-value-added work (Cooper and Edgett, 2012).

Creativity is an important dimension of innovation (Sundström and Zika-Viktorsson, 2009) but when organisations streamline how work is performed and encourage their employees to standardise work practices, teams are faced with a dilemma as to whether standardised work practices or creativity will enhance their overall effectiveness (Gilson et al., 2005). It has been found that linear models do not adequately represent the innovation process (Bledow et al. 2009) and the case company seems to be acting in a dynamic environment with a need for flexibility regarding project plans and requirements. When using project models based on linear and rational problem-solving it might instead do managers a great disservice (Lewis 2000).

5.1.4 PROJECT CHARACTERISTICS

According to Tatikonda and Rosenthal (2000), the project characteristics are critically important for the effective management of projects employing new technologies. Still, relatively little literature addresses the matter or associations between specific characteristics and success of the projects.

In product development there is a need for both individuals and teams to be creative and innovative, which requires them to be curious and to strive for newness. At the same time, these individuals and teams are supposed to produce efficiently and must focus on existing routines and close their minds to new ideas which will cause interruptions (Bledow et al., 2009). There seems to be a conflict in the case company between the ability to have projects running efficiently and simultaneously to leave room for exploration and the creation of knowledge. The fact that many of the phases in the projects are dependent on knowledge gained in earlier phases shows a need for flexibility and knowledge creation, which might suffer due to a strong focus on efficiency through a formalised process. As mentioned earlier there is a wish to have customer requirements clear and complete at the start of the project which does not seem realistic. Instead it has to be recognised that in development projects where customers have limited opportunities to formulate requirements in the early phases of the projects, the customer perspective has to rely primarily on the engineers' well-founded understanding of customers and their situation (Sundström and Zika-Viktorsson, 2009).

A reason for complexity in the projects is the dependencies between different design teams as the product consists of several components designed by different teams but with interdependencies. Creativity is needed when tasks are uncertain, while formal controls are needed when tasks are complex and interdependent (Adler and Chen, 2011). Tasks are often both uncertain, and complex and interdependent, requiring the ability of creativity and control simultaneously. Although many studies demonstrate that concurrent engineering can be a successful approach, some studies show the opposite (Valle and Vázquez-Bustelo, 2009). Minderhoud and Fraser (2005) suggest that concurrent engineering can be used to improve the efficiency of the development process, but to enhance the effectiveness of the process, iterative approaches must be used. For the case company, the approach of concurrent engineering seems to result in increased complexity, defeating its purpose. Concurrent engineering is supposed to increase efficiency by executing

tasks in parallel instead of sequentially. When there are dependencies between different parts of the project, this approach might instead lead to work having to be redone, resulting in inefficiency both regarding the overall lead time and use of resources.

As many projects have difficulties in following the project process according to the project model, it suggests that it is not tailored to fit the circumstances of this specific company, or at least difficult to tailor to fit specific projects, further suggesting that projects have different characteristics. As discussed in Paper I, customer projects have to some extent different characteristics than new product development projects. Some of the processes and methods used in both these kinds of projects are, however, often developed with the characteristics of new product development projects in mind. In the cases where projects include traits from both customer projects and new product development projects resulting in characteristics being contradictory, there is a risk of methods hindering the progress of the project instead of supporting it. This suggests that the context, in which the company acts, has not been considered when designing the development process. It also implies a need for process improvements with this combination of project characteristics in mind.

5.1.5 PROJECT MANAGEMENT

As complex systems create competing processes to achieve a desired outcome, organising paradoxes emerge, including e.g. tensions between routine and change (Smith and Lewis 2011). An example of tensions in product development is the need for both individuals and teams to be creative and innovative but at the same time produce efficiently and focus on existing routines (Bledow et al., 2009). Hence successful product development requires managing tensions through the combination of building innovative capacity and achieving efficient execution (Lewis et al., 2002).

Much organisation theory argues that organisations confront a trade-off between efficiency and flexibility, as efficiency requires bureaucracy and that bureaucracy impedes flexibility. Some researchers have, however, challenged this theory, arguing that there is a possibility to attain both superior efficiency and superior flexibility (Adler et al., 1999). Even though the development of detailed implementation plans are important for innovation, equally as important is the flexibility to be responsive to unforeseen events which might lead to giving up on previous plans and cause fundamental changes to the course of action (Bledow et al., 2009). Lewis et al. (2002) found that product development may require managers to use emergent and planned activities concurrently and be able to go back and forth between management styles as changes in project uncertainty occur, as well as to make trade-offs between competing demands.

There may be a need for teams to be skilled in using both creative and standardised approaches, as well as learning to adapt their work styles as circumstances call for (Gilson et al., 2005), requiring managers to adapt different behaviours according to contextual demands, the progress of the project, and the needs of individual

employees (Bledow et al., 2009). The case company has had difficulties in handling unexpected events which suggests a lack of understanding of how to manage and support the process. As the company is acting in a dynamic environment with a need for flexibility regarding project plans and requirements, and where tasks can be both uncertain and complex, there is a need for both control and creativity in the management of the projects. However, even though management styles are of great importance to innovation outcomes, little empirical research has directly examined how conflicting demands could be effectively managed and self-regulated (Anderson et al., 2014, Bledow et al., 2009).

5.1.6 BARRIERS TO CHANGE

There is much more resistance to institutional and organisational change than to technological change (Edquist, 1997). This must be considered when attempting to implement changes in order to be successful and actually achieve the intended improvements. One reason behind why there can be resistance to change is that the introduction of something new creates ambiguity and uncertainty for the individuals in an organisation (Birkinshaw et al., 2008). That individuals demonstrate a strong preference for consistency in their attitudes and beliefs and between their cognition and their actions can both hinder them from recognising the need for change as well as prevent them from adjusting to implemented changes. The result might be a mindless maintained commitment to previous behaviours in order to enable consistency between the past and the future. If the organisational structures support consistency, these commitments become reinforced (Smith and Lewis, 2011).

Another obstacle for improving performance could be that inconsistencies between core capabilities and innovation demands can lead to more use of existing strengths, resulting in missed opportunities for creative breakthroughs (Lewis, 2000). An example from the case company is the desire to have customer requirements clear and complete at the start of the project. As this is part of the current process design it might make more sense to attempt to try to follow the process stricter instead of rethinking the design of the process and recognising the need for change. However, some of the major capabilities of modern institutions come from their effectiveness in substituting rule-bound behaviour for individually autonomous behaviour (March and Olsen, 2004).

When the need for change has been recognised there might still be difficulties in identifying suitable improvements. When faced with uncertainty and a need for change, there is a risk of managers mimicking successful organisations by adopting their systems and processes (Simons, 1995), not suitable for their own organisation. A similar risk is that when using external change agents e.g. consultants, they might see their role as stimulating managers to adopt an existing or fashionable practice, rather than to create a new one (Birkinshaw et al., 2008). Bledow et al. (2009) propose that "one-best-way" recommendations for organisational innovation which do not take into account the specific situation and context of a given organisation are misguided and may even do more harm than add value. Instead the focus should be on the process towards tailoring the work practices according to the specific

company's needs, including the process of identifying the aspects which must be considered in order to be able to do so.

5.2 Proposed framework

Factors affecting the project performance must be considered on different levels: context, organisation, and project. On the context level characteristics in the external environment and business context which might affect the organisation and the projects must be identified and understood. On the organisation level characteristics of the organisational processes must be identified and understood, as well as their interaction with the context. Further, the characteristics of each specific project must also be well understood as these might vary. The project model and project management methods are applied to the projects in order to support the project's execution. The relationships between these areas are visualised in Figure 6.
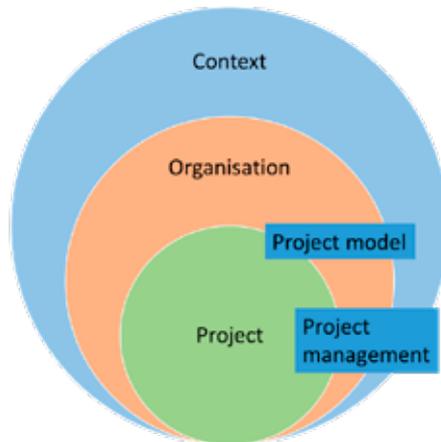

Figure 6: The relationships between the context, the organisation, the project, the project model, and project management.

Based on these findings the framework presented in Figure 7 is proposed as a support to find an approach which will result in increased process effectiveness and consequently increased project performance.
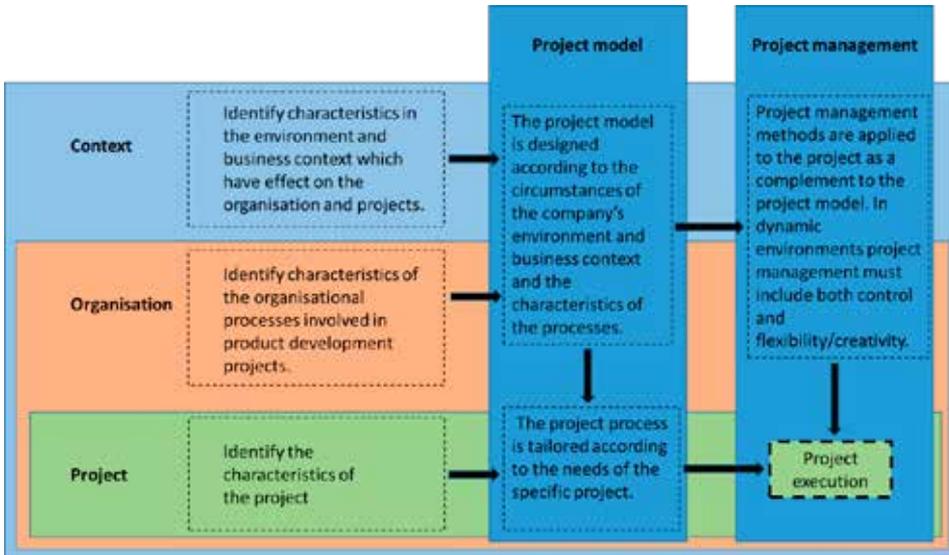
Figure 7: Proposed framework

The characteristics of the context and the characteristics of the organisational processes together form the base for developing a generic project model according to the circumstances of the company. This generic project model should then be tailored for each specific project's needs. As project management methods are applied to the project as a complement to the project model, the strategy for how to manage projects must have a dynamic fit with the project model. An effective project execution depends on a project process tailored for the specific need and a project management culture in accordance with the circumstances of the company's context.

At this stage, the proposed framework is more explanatory than a tool which can be practically used. However, it could possibly be used for self-diagnosis as a support for reviewing a project organisation and its deficiencies.

6 CONCLUSIONS AND FUTURE RESEARCH

6.1 Conclusions

Based on the research objective of increasing the knowledge of how the performance of the projects in a product development context can be improved, two research questions were formulated. The answers to these questions have been developed throughout the thesis and in this chapter the conclusions are summarised.

RQ1: What factors influence project performance?

From very early on in this research project the concepts of efficiency and effectiveness have played a central part. As project performance depends on both efficiency and effectiveness though the focus most often is on efficiency, the focus of this research project has instead been primarily on how to increase the effectiveness of the projects, which in turn should lead to the possibility of increasing their efficiency.

It became evident that there was a need to rethink the view on effectiveness. Both in previous research and in the industry, effectiveness has mainly been connected to the output of the project such as achieving the predetermined objective, the degree to which the actual result corresponds to the result at, or the extent to which customer requirements are met. Regarding the process of product development projects the focus is mostly on efficiency. However, with the continuous interface between the customer and the external environment throughout the process of the project, the need to discuss process effectiveness was identified.

To really make the projects effective, with particular focus on making the project process effective, there must be a holistic view of the project performance. Therefore, factors influencing project performance were considered on all levels, from the individual working in the project to the external environment and business context in which the organisation acts.

The combination of business context characteristics, process characteristics, and project characteristics were identified has having influence on the project performance. Further, the design of the project model which is used in the projects, as well as the project management methods employed, will have an impact on the project performance.

RQ2: How can project performance be improved?

Since continuous improvement work is common in most companies, the question why improvement initiatives do not always have the intended effect had to be addressed. Further, it was found that improvement initiatives can often be misdirected caused by an inaccurate view of where improvements are needed in order to increase performance.

Institutions and institutionalised behaviour was identified as a reason behind why there are mismatches between individuals' experiences and their actions. There is a resistance to change in general, and to institutional and organisational change in

particular. When there are inconsistencies between the core capabilities of the organisation and the demands for innovation, it should ideally lead to a recognised need for change. However, it can instead result in more use of the existing strengths, and opportunities for creative breakthroughs are missed. This suggests that for an organisation to achieve management innovations which will lead to increased performance, institutional change could be required in order to be able to accept and adapt to the management change.

Based on the factors identified as influencing project performance, a start of a framework was developed, proposed as a support to find an approach which will result in increased process effectiveness and consequently increased project performance.

6.2 Research contribution

The research problem is inspired by a practical problem at the case company, but the contribution at this stage of the research project is mainly scientific due to the descriptive nature of the research. However, the start of developing a framework for improving project performance represents the practical contribution.

The scientific contribution lies in the increased understanding of project performance, the factors which influence project performance and how project performance can be improved. The concept of process effectiveness has been investigated and the importance of it has been highlighted. Even though no generally accepted definition of process effectiveness exists, proposed definitions to build on for product development in dynamic contexts have been framed. Further, the areas which need to be considered when attempting to increase effectiveness and consequently the overall project performance have been identified and discussed.

The proposed framework for improving project performance, presented and described in section 5.2.2, represents the practical contribution of this research project. The framework is, however, still on a conceptual level and needs to be developed further before its usability can be assured.

6.3 Quality and limitations of the research

Although it is considered that the objective of the research has been fulfilled and that the research questions have been answered, it must be addressed that the chosen research methods and research design will influence the conclusions which can be drawn from the research. The quality and limitations of the research will therefore be reviewed in this section.

The strategies for increasing the quality of the research project related to validity and reliability were discussed in section 3.4. The actions taken to increase the internal validity and ensure that the research findings match reality can be seen as adequate. Regarding external validity the results cannot be generalised to other settings. However, generalisability in that sense has not been striven for. As stated by Yin (2009), case studies rely on analytical generalisation, where a particular set of results are generalised to some broader theory, which has been the aim in this

research project. Further, the approach of ensuring transparency of the empirical results has been aimed at through descriptive and detailed presentation of both the setting and the findings. Reliability in the sense of being able to replicate the results is difficult to achieve in qualitative studies, and reliability should instead be related to if the results are consistent and dependable (Merriam, 2009). As similar strategies can be used to increase both internal validity and reliability, and several of these were considered in the project, the reliability can be seen as adequate.

Generally, there are some limitations regarding the quality of the research related to the fact that this research is performed within the process of a research education. The knowledge regarding how to perform research has, consequently, evolved over the course of the research project. Further, as the first stages of the project have had an explorative approach, the literature studied has covered several theoretical areas which means that knowledge within each area still is limited.

6.4 Future research
As this thesis only covers the first half of a project towards a PhD, the findings have inspired several different topics for the second part of the project. The research objective has been to increase the knowledge of how the performance of the projects in a product development context can be improved. Interesting areas for this further research are therefore mainly related to how to practically improve project performance.

The framework for how to improve project performance proposed in this thesis is, as previously mentioned, still on a conceptual level and needs to be developed further. As it is based on empirical data from a single case study it would be interesting to study more companies in order to increase its applicability. Each area within the framework also needs to be developed further in order to describe how it should be practically used. Further, its usability must be empirically tested.

Related to the management of product development projects, previous research shows that little empirical research has directly examined how conflicting demands could be effectively managed and self-regulated. Since the need for ways to manage conflicting demands has been identified it suggests that there is a gap which needs to be filled. Hence this is another interesting area for further research.

A third area which needs to be investigated further is related to the barriers to change. Institutions have been identified as an obstacle when trying to achieve management innovations. Institutional change might therefore be a prerequisite for many organisations in order to successfully implement improvements resulting in increased project performance, and further research into how organisations can perform institutional changes is therefore required.

REFERENCES

ADLER, P. S. & CHEN, C. X. 2011. Combining creativity and control: Understanding individual motivation in large-scale collaborative creativity. *Accounting, Organizations and Society,* 36**,** 63-85.

ADLER, P. S., GOLDOFTAS, B. & LEVINE, D. I. 1999. Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science,* 10**,** 43-68.

AKGÜN, A. E., BYRNE, J. C., LYNN, G. S. & KESKIN, H. 2007. New product development in turbulent environments: Impact of improvisation and unlearning on new product performance. *Journal of Engineering and Technology Management,* 24**,** 203-230.

ANDERSON, N., POTOČNIK, K. & ZHOU, J. 2014. Innovation and Creativity in Organizations: A State-of-the-Science Review, Prospective Commentary, and Guiding Framework. *Journal of Management,* 40**,** 1297-1333.

ARBNOR, I. & BJERKE, B. 1994. *Företagsekonomisk metodlära*, Studentlitteratur.

BIRKINSHAW, J., HAMEL, G. & MOL, M. J. 2008. Management Innovation. *Academy of Management Review,* 33**,** 825-845.

BLEDOW, R., FRESE, M., ANDERSON, N., EREZ, M. & FARR, J. 2009. A dialectic perspective on innovation: Conflicting demands, multiple pathways, and ambidexterity. *Industrial and Organizational Psychology,* 2**,** 305-337.

BLESSING, L. T. & CHAKRABARTI, A. 2009. *DRM: A Design Research Methodology*, Springer.

BROWN, S. L. & EISENHARDT, K. M. 1995. Product Development: Past Research, Present Findings, and Future Directions. *Academy of Management Review,* 20**,** 343-378.

BRUNSSON, N. & OLSEN, J. P. (eds.) 1990. *Makten att reformera,* Stockholm: Carlsson Bokförlag.

CARLILE, P. R. & CHRISTENSEN, C. M. 2004. The cycles of theory building in management research.

CEDERGREN, S. 2011. *Performance in Product Development-The Case of Complex Products*. Mälardalen University.

CHECKLAND, P. 2000. Soft systems methodology: a thirty year retrospective. *Systems Research and Behavioral Science,* 17**,** S11-S58.

CHECKLAND, P. & POULTER, J. 2010. Soft systems methodology. *In:* REYNOLDS, M. & HOLWELL, S. (eds.) *Systems approaches to managing change: A practical guide.* London: Springer.

CLARKSON, J. & ECKERT, C. 2010. *Design process improvement: a review of current practice,* London, Springer.

COOPER, R. G. 1990. Stage-gate systems: a new tool for managing new products. *Business Horizons,* 33**,** 44-54.

COOPER, R. G. Winning at new products: pathways to profitable innovation. Project Management Research Conference, 2006 Montreal, Canada. MPM.

COOPER, R. G. 2008. Perspective: The Stage-Gate® Idea-to-Launch Process—Update, What's New, and NexGen Systems*. *Journal of Product Innovation Management,* 25**,** 213-232.

COOPER, R. G. & EDGETT, S. J. 2012. Best practices in the idea-to-launch process and its governance. *Research-Technology Management,* 55**,** 43-54.

CRAVENS, K. S., OLIVER, E. G. & STEWART, J. S. 2010. Can a positive approach to performance evaluation help accomplish your goals? *Business Horizons,* 53**,** 269-279.

DE WEERD-NEDERHOF, P. C., VISSCHER, K., ALTENA, J. & FISSCHER, O. A. 2008. Operational effectiveness and strategic flexibility: scales for performance assessment of new product development systems. *International Journal of Technology Management,* 44**,** 354-372.

DRUCKER, P. 1974. *Management: Tasks, responsibilities, practices,* New York, Harper & Row.

EDQUIST, C. (ed.) 1997. *Systems of innovation: technologies, institutions, and organizations,* London: Pinter.

FRICKE, E., GEBHARD, B., NEGELE, H. & IGENBERGS, E. 2000. Coping with changes: causes, findings, and strategies. *Systems Engineering,* 3**,** 169-179.

GIGERENZER, G. 2008. *Rationality for mortals: How people cope with uncertainty,* New York, Oxford University Press.

GILSON, L. L., MATHIEU, J. E., SHALLEY, C. E. & RUDDY, T. M. 2005. Creativity and standardization: complementary or conflicting drivers of team effectiveness? *Academy of Management Journal,* 48**,** 521-531.

GRIFFIN, A. 2002. Product development cycle time for business-to-business products. *Industrial Marketing Management,* 31**,** 291-304.

HARGRAVE, T. J. & VAN DE VEN, A. H. 2006. A collective action model of institutional innovation. *Academy of Management Review,* 31**,** 864-888.

HOEGL, M. & GEMUENDEN, H. G. 2001. Teamwork quality and the success of innovative projects: A theoretical concept and empirical evidence. *Organization Science,* 12**,** 435-449.

HOLME, I. M., SOLVANG, B. K. & NILSSON, B. 1997. *Forskningsmetodik: om kvalitativa och kvantitativa metoder*, Studentlitteratur.

JACOBSEN, D. I. & THORSVIK, J. 2008. *Hur moderna organisationer fungerar,* Lund, Studentlitteratur.

JUGDEV, K. & MULLER, R. 2005. A retrospective look at our evolving understanding of project success. *Project Management Journal,* 36**,** 19-31.

KEKÄLE, T., DE WEERD-NEDERHOF, P., VISSCHER, K. & BOS, G. 2010. Achieving sustained innovation performance through strategic flexibility of new product development. *International Journal of Innovation and Learning,* 7**,** 377-393.

KVALE, S. & TORHELL, S.-E. 1997. *Den kvalitativa forskningsintervjun*, Studentlitteratur.

LEWIS, M. W. 2000. Exploring paradox: Toward a more comprehensive guide. *Academy of Management Review,* 25**,** 760-776.

LEWIS, M. W., WELSH, M. A., DEHLER, G. E. & GREEN, S. G. 2002. Product development tensions: Exploring contrasting styles of project management. *Academy of Management Journal,* 45**,** 546-564.

MARCH, J. G. & OLSEN, J. P. 2004. *The logic of appropriateness*, ARENA.

MARION, T. J. A framework for balancing efficiency and effectiveness in innovative product design. ICED'09, International Conference on Engineering Design, 2009 Palo Alto, USA. 10.

MARMGREN, L. & RAGNARSSON, M. 2001. *Organisering av projekt: från ett mekaniskt till ett organiskt perspektiv,* Stockholm, Fakta info direkt.

MARMGREN, L. & RAGNARSSON, M. 2014. *Att leda osäkra och komplexa projekt : från styrning och kontroll till stöd för självorganisering,* Lund, Studentlitteratur.

MERRIAM, S. B. 2009. *Qualitative research: A guide to design and implementation,* San Francisco, Jossey-Bass.

MILES, M. B. & HUBERMAN, A. M. 1994. *Qualitative data analysis: An expanded sourcebook*, Sage.

MINDERHOUD, S. & FRASER, P. 2005. Shifting paradigms of product development in fast and dynamic markets. *Reliability Engineering & System Safety,* 88**,** 127-135.

MOORMAN, C. & MINER, A. S. 1998. The convergence of planning and execution: Improvisation in new product development. *The Journal of Marketing,* 62**,** 1-20.

NEELY, A., GREGORY, M. & PLATTS, K. 2005. Performance measurement system design: a literature review and research agenda. *International Journal of Operations & Production Management,* 25**,** 1228-1263.

NORMANN, R. 2001. *När kartan förändrar affärslandskapet,* Malmö, Liber.

NORTH, D. C. 1990. *Institutions, institutional change and economic performance*, Cambridge university press.

O'DONNELL, F. & DUFFY, A. 2002. Modelling design development performance. *International Journal of Operations & Production Management,* 22**,** 1198-1221.

OJANEN, V. & TUOMINEN, M. An analytic approach to measuring the overall effectiveness of R&D-a case study in the telecom sector. Engineering Management Conference, IEMC'02, 2002. IEEE International, 667-672.

PARK, H. & CUTKOSKY, M. R. 1999. Framework for modeling dependencies in collaborative engineering processes. *Research in Engineering Design,* 11**,** 84-102.

RIDLEY, D. 2008. *The literature review: A step-by-step guide for students*, Sage.

ROBSON, I. 2004. From process measurement to performance improvement. *Business Process Management Journal,* 10**,** 510-521.

RÄMÖ, H. 2002. Doing things right and doing the right things Time and timing in projects. *International Journal of Project Management,* 20**,** 569-574.

SIMON, H. A. 1991. Bounded rationality and organizational learning. *Organization Science,* 2**,** 125-134.

SIMONS, R. 1995. *Levers of control: how managers use innovative control systems to drive strategic renewal,* Boston, Harvard Business School Press.

SMITH, W. K. & LEWIS, M. W. 2011. Toward a theory of paradox: A dynamic equilibrium model of organizing. *Academy of Management Review,* 36**,** 381-403.

SMITH, W. K. & TUSHMAN, M. L. 2005. Managing strategic contradictions: A top management model for managing innovation streams. *Organization Science,* 16**,** 522-536.

SUNDSTRÖM, P. & ZIKA-VIKTORSSON, A. 2009. Organizing for innovation in a product development project: Combining innovative and result oriented ways of working–A case study. *International Journal of Project Management,* 27**,** 745-753.

SÄFSTEN, K., JOHANSSON, G., LAKEMOND, N. & MAGNUSSON, T. 2010. Effektiv produktframtagning: analys och hantering av osäkerhet, komplexitet och spridning.

SÖDERLUND, J. 2004. Building theories of project management: past research, questions for the future. *International Journal of Project Management,* 22**,** 183-191.

TATIKONDA, M. V. & ROSENTHAL, S. R. 2000. Technology novelty, project complexity, and product development project execution success: a deeper look at task uncertainty in product innovation. *Engineering Management, IEEE Transactions on,* 47**,** 74-87.

THOMKE, S. & FUJIMOTO, T. 2000. The Effect of "Front-Loading" Problem-Solving on Product Development Performance. *Journal of Product Innovation Management,* 17**,** 128-142.

THOMKE, S. H. 1997. The role of flexibility in the development of new products: An empirical study. *Research Policy,* 26**,** 105-119.

VALLE, S. & AVELLA, L. 2003. Cross-functionality and leadership of the new product development teams. *European Journal of Innovation Management,* 6**,** 32-47.

VALLE, S. & VÁZQUEZ-BUSTELO, D. 2009. Concurrent engineering performance: Incremental versus radical innovation. *International Journal of Production Economics,* 119**,** 136-148.

VAN REE, H. J. 2002. The added value of office accommodation to organisational performance. *Work Study,* 51**,** 357-363.

VARGO, S. L. & LUSCH, R. F. 2008. From goods to service (s): Divergences and convergences of logics. *Industrial Marketing Management,* 37**,** 254-259.

WEICK, K. E. 2001. *Making sense of the organization,* Malden, MA, Blackwell.

WHEELWRIGHT, S. C. & CLARK, K. B. 1992. *Revolutionizing product development: quantum leaps in speed, efficiency, and quality,* New York, Free Press.

WILLIAMSON, K. 2002. *Research methods for students, academics and professionals: Information management and systems*, Elsevier.

WINTER, M. & CHECKLAND, P. Soft systems: a fresh perspective for project management. ICE-Civil Engineering, 2003. Ice Virtual Library, 187-192.

YIN, R. K. 2009. *Case study research: Design and methods*, Sage.