ERP SYSTEM IMPLEMENTATION: HOW TOP MANAGERS' INVOLVEMENT IN A CHANGE PROJECT MATTERS

NHH

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To my daughter Maud Johanne

Abstract

The purpose of this thesis is to enhance the understanding of how top managers' involvement in an ERP system implementation project may affect organisational effectiveness. Top managers must be involved in ERP system implementations because an ERP system spans the whole organisation. Only the top manager has the authority to make decisions at the level above the units that will be influenced by the implementation. In the literature, however, the role of the top managers' involvement is described in vague terms only.

To study the significance of top management involvement, I have conducted a longitudinal study examining the implementation of an ERP system in an international production enterprise. To take care of competitive advantages, the project comprised the development of two custom-made ERP system modules, a sales module and a corporate production-planning module. The complexity of the project, which is attributable to its custom-made modules, makes great demands on the management of the project. I have conducted more than 50 interviews with the top managers and some of the employees, and I have observed and modelled work processes in detail, the sales process and the production-planning process.

In my study, the top managers were involved in all phases of the implementation. In the initiation phase, they developed the vision of the enterprise "to be", and they communicated the vision and the need for the system to their employees. They participated in the development of the invitation to tender, emphasising the distinctive characteristics of the production processes. Furthermore, they allocated resources to prepare the enterprise for the ERP system, among others, by standardising names of components. This involvement in the initiation and planning phases contributed to cost savings in later project phases.

During the project period, the top managers were members of the steering committees, allocating resources to compose project teams with local specialists and external experts. However, this phase also revealed that the top managers were not able to manage a complex project adequately. After a period of scope increase and heavy delays related to the development of the production-planning module, the managers and members of the project teams learned the need for more agile project management from experience, and the rest of the project was implemented according to plan.

I have explored the effects that derived from the ERP system implementation and how these effects influenced organisational effectiveness. I found that the main effects were improvements in the effectiveness of the extended supply chain, such as improved exploitation of capacities, reduction of managerial lead-times, reduction of costly mistakes, and improved services to the customers. The corporate production-planning module made 13 local planners redundant; that is, they were employed elsewhere in the enterprise.

In addition, my thesis has contributed to the development of tools that help researchers get an overview of a large quantity of data. I have extended an information system implementation model to include the representation of sub-projects, and I have extended a process modelling technique so that it is suitable for comparing work processes and highlighting the effects of process changes.

My thesis contributes to the understanding of the top managers' role in ERP system implementation projects: developing the vision, communicating that vision, allocating relevant resources, and active participation in all phases of the project. In my case study, the top managers understood the potential of information technology to increase the effectiveness of the enterprise, and they had a detailed knowledge of the production and management processes. This knowledge made it easier for them to take an active role in the project. They just lacked the knowledge of agile project management.

My findings support the importance of dividing a complex project into more manageable sub-projects. In addition, my study demonstrates that it is essential to evaluate the complexity of each sub-project critically and to select an adequate implementation strategy. In projects dealing with software development and work process development, this critical evaluation should concern both the technical complexity of the software solution and the organisational complexity.

My findings have implications for managers. Managers who are not mastering project management principles need two types of consultants when they are involved in ERP system projects. Because of the technological complexity, managers need consultants from the vendor when they implement an ERP package. They may also need other types of specialists, such as programmers, when the project involves the development of custom-made software. In addition, they need the support of a professional project manager to help them apply appropriate project management methodologies to achieve the project goals in time and on budget.

Keywords: ERP system, ERP system implementation, project management, agile project management, top managers, implementation strategies, critical success factors, modelling techniques.

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Heidi Buverud

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List of Abbreviations

BoB	Best of breed
BPR	Business Process Reengineering
CPM	Critical Path Method
CR	Change Requirement
CSF	Critical Success Factor
ERP	Enterprise Recourse Planning
GDPM	Goal-Directed Project Management
HQ	Head Quarter
HR	Human resource
Pack	The ERP package
PERT	Program Evaluation and Review Technique
PM	Production-planning Module
PM2	Production-planning Module 2
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PrOrReg	Production Order Registration
ProSpeCo	Product Specification Constraints
RIC	Roles In Cooperation
RID	Role Interaction Diagram
SM	Sales Module
TLS	Traffic Light System
TPS	Third party system

1 Introduction

The purpose of this thesis is to enhance the understanding of how managers should implement Enterprise Resource Planning (ERP) systems to increase the effectiveness of business organisations. ERP systems are computerised information systems (IS) that support and integrate several functional areas of a business (Jessup, Valacich, & Wade, 2006).

This thesis is based on the assumption that ERP systems have a substantial potential for increasing the effectiveness and efficiency of business and management processes by integrating and enabling completely new business and administrative processes. This thesis also works on the assumption that the managers' involvement in the ERP system implementation project is critical to attain organisational goals.

At the beginning of the twenty-first century, the implementation of ERP systems usually consisted of the adaptation of packaged software systems. The focus of the implementation was on the selected software package and the adaptation of the business to the "best practices" represented in the package. The development of standard interfaces among system modules has changed this picture. Today, it is possible to implement ERP systems based on modules from various vendors, and the opportunities to adapt the modules to the particular needs of specific firms have increased. Thus, the focus of implementation projects has shifted towards selecting the "best of breed" system modules and taking care of or developing competitive advantages exploiting the potential of the new technology. Such exploitation may involve custom-made modules.

Accordingly, in this thesis, an ERP system refers to a computerised information system (IS) that supports and integrates several functional areas of a business, including planning, manufacturing, purchasing, sales, human resources (HR), and finance (Jessup et al., 2006). An ERP system should become an integral part of the business and support its operations, tactical movement and strategic direction (Chen, Law, & Yang, 2009).

Business managers invest in ERP systems to enhance organisational effectiveness. However, for organisations to benefit from the investments, ERP systems must be adequately implemented. ERP system implementation remains one of the most significant challenges for managers, employees and consultants (Uwizeyemungu & Raymond, 2009). The reason is the complexity and uncertainty involved, and the fact that ERP system implementations correspond to "organisational change" projects (Volkoff, 1999). To reap the potential benefits of the investment, implementing an ERP system often involves disruptive organisational changes.

Furthermore, an ERP system implementation may require years of implementation and post implementation (Chen et al., 2009; Parr & Shanks, 2000b), and the systems may cost millions of dollars to buy and several times that to implement (Aloini, Dulmin, & Mininno, 2007).

Since ERP projects span organisations, top managers must be involved in the projects because only the top managers have the authority to make decisions on behalf of the entire organisation. However, top managers in business enterprises are not always trained to manage large and complex projects. They do not fully understand the complexity, size, and risks involved in ERP implementation projects (Ferratt, Ahire, & De, 2006). My review of the ERP system implementation literature shows that managers fail to explicitly assess the level of complexity in such projects (Ferratt et al., 2006; Ghosh & Skibniewski, 2010; Krasner, 2000).

ERP systems have an inherent potential to increase the effectiveness of business and managerial processes. However, because of their complexity many ERP projects do not meet their predetermined goals and are reported as failures, see, for example, Ranjan, Jah and Pal (2016), Barker and Frolick (2003), Chen, Casper and Cortina (2001).

There is a clear need to enhance the understanding of how to manage ERP projects effectively. Chen et al. (2009) found that despite the importance of project management in ERP implementation, the literature on project management contains surprisingly little research specifically related to ERP.

In line with the inherent complexity and long-time perspective of ERP projects, there is a call for more longitudinal process studies that capture critical events and actions that explain the outcomes of implementation projects, see, for example, Robey, Ross and Boudreau (2002), Sedmak (2010), and Ghosh and Skibniewski (2010). According to Ghosh and Skibniewski (2010), a new body of knowledge regarding the governance and management of complex projects should be developed to improve coordination among actors involved in implementing an ERP system.

Furthermore, ERP system technologies are being developed continuously, requiring new analyses and understanding of the potential and pitfalls in implementation projects (Uwizeyemungu & Raymond, 2009). Ghosh and Skibniewski (2010) call for research that includes data collection from ERP system adopters and longitudinal analyses of trends based on advances in ERP project management and governance capabilities in different ERP system implementations. The calls for research include the need for models that can guide longitudinal process studies (Sedmak, 2010). This thesis will help close this gap by assessing the complexity in an ongoing ERP system implementation project and by proposing an extension of a model by Lyytinen and Newman (2006, 2008) (see below) that allows researchers to portray the complexity of ERP implementations in more detail.

Based on the above-mentioned gaps in the literature and the calls for research (see details in the literature review), my research question in this study is:

> **How can top managers' involvement in ERP system projects affect the implementation processes and subsequently organisational effectiveness?**

To answer my research question, this thesis describes an exploratory research study in which a project management perspective is used to analyse a case study of an ERP system implementation in a multinational production enterprise.

In this thesis, I have analysed an ERP system implementation project. Based on the analysis, I have evaluated and discussed the appropriateness of selected implementation approaches. Thereafter, I analysed selected work processes to identify the effects of the ERP system implementation. I explain these effects and discuss if and how they may have affected organisational effectiveness.

Several researchers have proposed so-called waterfall models of ERP system implementations to theorise about and explain them. In waterfall models, the implementation project is seen as a phased and linear process (Bancroft, Seip, & Sprengel, 1998; Markus & Tanis, 2000; Parr & Shanks, 2000a; Ross & Vitale, 2000). However, the ERP system implementation literature needs to go beyond the linear way of looking into ERP system implementations (Ghosh & Skibniewski, 2010). The consequence of failing to see ERP system implementation as a complex and iterative process may be the loss of project management control. This thesis contributes to the current body of knowledge by helping to enhance the understanding of how to manage the complexity of ERP system implementation projects.

I also present a model to guide the description and analysis of ERP system implementation processes, cf. the call from Sedmak (2010) for models to guide longitudinal process studies.

The usual way of presenting process data is a table with a time line and textual explanations of events and actions, see, for example, Plowman et al. (2007), Akkermans and Helden (2002), and, Swan, Bresnen, Newell, Robertson, and Dopson (2010). This presentation form is useful because it takes care of contextual details to explain outcomes. The drawback is the lack of overview that is essential to analyse and understand complex processes. The PSIC model by Lyytinen and Newman (2006, 2008) gives a useful visual overview of a longitudinal process, but their approach does not represent implementation processes involving several sub-systems, such as ERP systems, and their approach does not focus on intermediary outcomes during longitudinal processes.

I have adapted and extended the model by Lyytinen and Newman (2006, 2008) to reflect my research purpose and needs for presentation and analysis of data. My model provides an overview of an ERP system implementation process that involves sub-systems and intermediary results, thus supporting the understanding of what causes the project's successes and failures.

The remainder of this thesis is structured as follows. In Chapter 2, the ERP system implementation literature is reviewed and critically assessed. The purpose of the review is to identify the gaps I attempt to fill with this thesis. The gaps are summarised above.

In Chapter 3, I present the conceptual frameworks applied in the thesis to answer my research question. These frameworks are the principles of project management and system design and implementation strategies for complex system development projects.

In Chapter 4, I describe my research design and the requirements to my empirical setting. I also explain how I have collected and analysed data.

In Chapter 5, I present the organisation from which I have collected my data. In this chapter, I also present a context-specific framework for evaluating organisational effectiveness based on the managers' description of organisational goals and their perceptions of factors critical to attain organisational goals.

In the following two chapters, I present my analyses. Chapter 6 gives an overview of the implementation process from the initial planning until the ERP system is used as intended. In Chapter 7, I relate the effects of the implementation to organisational effectiveness, emphasising two work processes, the production-planning process and the sales process.

In Chapter 8, I summarise the effects of the implementation of the ERP system and relate the effects to the top managers' involvement in the implementation project.

In Chapter 9, I present my conclusion and discuss the implications of my findings. Furthermore, I discuss the limitations of my study along with suggestions for further research.

2 Literature review – ERP systems research during two decades

The purposes of this review are to explain essential concepts, position my thesis alongside existing knowledge in the field of ERP system implementation and identify critical knowledge gaps to be bridged by my research. The existing ERP literature is voluminous and complex (Ali & Miller, 2017), and to get an overview of the literature, I chose to start my literature review with the articles reviewing the ERP research field. Thus, I have chosen to organise my review in two parts:

In the first part, I present an analysis of nine review articles published between 2001 and 2017. In the second part, I elaborate on the work published in various journals on the topics of ERP system and ERP system implementation. The organisation of the second part is based on issues that were raised during the discussions of ERP system implementation in part I, and that are relevant to position my research contribution.

2.1 Part I – point of departure for review

In this section, nine review articles are analysed to investigate how the concepts of ERP systems and ERP system implementations are defined in the literature. In particular, the various taxonomies applied in the reviews are compared and contrasted to extract the critical issues related to ERP system implementation and identify the research issues that will be discussed further in part II.

The basic structure of the presentation of each review is summarised in Table 2.1, which is organised as follows: The review articles are listed in each row in the order they were published. Article number, year published and author(s) are presented in column one, two and three respectively. In column four, the number of published papers included in each review on the topics of ERP is indicated. Some of the reviews build on previously published reviews. Column five refers to these review articles, and the articles are referred to by their numbers in column one. The timespan in which the reviewed articles were published is indicated in column six. The taxonomy applied to organise the research articles reviewed in each study are presented in column seven. In columns eight and nine I have noted how the authors define or describe the concepts of an ERP system and ERP system implementation.

Table 2.1 Review articles published between 2001 and 2017

No	Year	Author(s)	Papers reviewed	Reviews reviewed	Time-span	Taxonomy	Description/definition of ERP/ERP system	Description/definition of ERP system implementation
1	2001	Esteves and Pastor	189	-	1997-2000	ERP life cycle framework: adoption decision, acquisition, implementation, use and maintenance, evolution and retirement phase + For publications not related to the ERP lifecycle phases: research issues, organisational knowledge, business modelling and product development	Software packages composed of several modules, such as human resources, sales, finance and production, providing cross-organization integration of data through embedded business processes.	The implementation phase deals with the customisation or parameterisation and adaptation of the ERP package acquired to meet the needs of the organisation
2	2004	Shehab et al.	76	-	1990-2004	Selection and implementation. The implementation category is further divided into implementation approaches, factors affecting the implementation process and implementation models	A business management system that comprises integrated sets of comprehensive software, which can be used to manage and integrate all the business functions within an organisation.	The scope of ERP implementation encompasses what is often referred to as the entire value chain of the enterprise, from prospect and customer management through order fulfilment and delivery
3	2005	Botta-Genoulaz et al.	80	-	2003-2004	Implementation, Optimisation, Management, ERP tool, Supply chain management and Case studies	A suite of enterprise business applications that include at least financial and human resources applications and either SCM (supply chain management) or CRM (customer relationship management)	Perspective on implementation included management and cultural issues in their discussions as well as reasons for success and failures and the systems' impact on organisational performance
4	2005	Cumbie et al.	49	-	1999-2004	ERP Implementation, ERP operation and ERP benefits	An enterprise wide software solution for integrating data from many functions within the organization operating from a central database to support planning and the flow of information within the organization.	The process of integrating an ERP system into an organisation in which no previous ERP system existed.
5	2007	Esteves and Bohorquez	640	1 and 2	2001-2005	ERP life cycle framework: adoption decision, acquisition, implementation, use and maintenance, evolution and retirement phase + For publications not related to the ERP lifecycle phases: research issues, business modelling and ERP product development issues	No explicit definition	The implementation phase deals with the customisation or parameterisation and adaptation of the ERP package, according to the needs of the organisation. Usually this task is made with the help of consultants who provide implementation methodologies, know-how, and training.
6	2007	Moon	313	1 and 3	2000-2006	Implementation, Using ERP, Extension, Value, Trends and perspectives and Education	The ERP system is an enterprise information system designed to integrate and optimise the business processes and transactions in a corporation.	Implementing an ERP system is a major project requiring a significant level of resources, commitment and changes throughout the organisation.

7	2010	Schlichter and Kraemmergaard	885	1 to 5	2001-2009	**Topic:** Implementation, optimisation of ERP, management and ERP issues, the ERP tool, ERP and supply change management, studying ERP, ERP and education, the ERP market and industry, other **Discipline:** Information systems, accounting, organisation and management, operations management (SCM), computer science, other **Method:** Case study, archival, theoretical, survey, combination, design science, not mentioned, descriptive/normative, experimental	Refers to Ross et al. (2006) who defines an ERP system as a business management system that comprises integrated sets of comprehensive software, which can be used to manage and integrate all the business functions within an organisation with a rationalised data architecture characterised by core process integration and shared product and/or customer databases	Implementation is described as how the ERP system can be introduced into the organisation. Implementation includes system selection, the various steps of implementation and related problems, critical success factors, business process alignment during the implementation and organisational diffusion
8	2016	Ranjan et al.	32		2008-2014	ERP implementation challenges from four different approaches: technology selection, change management, knowledge management and emerging technologies	ERP systems enable an organisation to integrate all its primary business processes in order to enhance efficiency and maintain a competitive position.	ERP implementation is a challenging and expensive task that not only requires rigorous efforts but also demands to have a detailed analysis of such factors that are critical to the adoption or implementation. The authors focus on ERP implementation challenges from four different perspectives: technology selection; change management, knowledge management and emerging technologies.
9	2017	Ali and Miller	215/149	4 and 5	1989-2016	The articles were classified based on the ERP lifecycle framework developed by Esteves and Bohorquez (2007), with a particular focus on pre-implementation, implementation and post-implementation.	Packaged business software system that enables companies to effectively and efficiently manage resources (material, human resources, finance, etc.) by providing a total integrated solution for an organisation's information-processing needs.	ERP implementation is the process through which technical, organisational, and financial resources are configured to provide an efficient operating system (Fleck, 1994).

1) Review number one, conducted by Esteves and Pastor in 2001, is an annotated bibliography presenting ERP system publications in major journals and conferences about information systems. The article reviewed the state of the diffusion of ERP systems during the period of 1997-2000. The review included a total of 189 publications from a small number of sources, most of which were conference papers.

Esteves and Pastor (2001) defined ERP systems as "software packages composed of several modules, such as human resources, sales, finance and production, providing cross-organisation integration of data through embedded business processes".

The authors categorised the ERP articles according to a linear ERP life-cycle framework consisting of six phases: Adoption decision, Acquisition, Implementation, Use and maintenance, Evolution and retirement (ibid., pp. 12-14). The Adoption Phase comprises the evaluation of the need of an ERP system and the definition of system requirements. The Acquisition Phase involves selecting the package that best fits the organisation's requirements, in order to minimise the need for customisation. The Implementation Phase deals with the customisation or parameterisation and adaptation of the ERP package to meet the needs of the organisation, usually with the help of consultants. The Use and maintenance Phase consists of using the product to return the expected benefits. The Evolution Phase involves the integration of additional capabilities, and the Retirement Phase evaluates whether the system should be substituted with another. The ERP life-cycle framework provided by the authors is structured into six phases and constitutes a linear implementation process.

Esteves and Pastor (2001) mention the role of managers only in connection with the Adoption decision phase and the Retirement phase. In the Adoption phase the managers must question the need of a new ERP system, and in the Retirement phase the managers must decide whether they will substitute the system with another information system approach that is more adequate.

The publications analysed in this review showed that researchers during the 1997- 2000 period engaged in issues mainly related to the implementation phase. According to the authors, one of the reasons was that most organisations were in this phase. Furthermore, the authors found that the notion of implementation did not mean the same thing to everyone, and that each author had their own model of implementation phases (Esteves & Pastor, 2001). In connection with implementation success, the authors stated that some of the studies did not provide a precise definition of the critical success factors (ibid., p. 20).

The topic of project management was only mentioned once as one of the elements to be considered in an ERP-software implementation (Esteves & Pastor, 2001).

2) The review by Shehab, Sharp, Supramaniam and Spedding (2004) includes 76 publications published from 1990 to 2004. However, only eight articles were published before 2000, and all eight were published between 1997 and 1999.

Shehab et al. (2004) described an ERP system as a "business management system that comprises integrated sets of comprehensive software, that can be used, when successfully implemented, to manage and integrate all the business functions within an organisation".

The authors classified the literature according to selection criteria of an ERP system and implementation of an ERP system. The implementation category is divided into implementation approaches, factors affecting the implementation process and implementation models.

With regard to the selection criteria, Shehab et al. (2004) stated that an ERP system can be put together in a number of ways, and they describe two selection approaches – a single-vendor solution and a multi-vendor solution. Both approaches are undoubtedly complex due to their scale, scope and Business Process Redesign (BPR) requirements (Shehab et al., 2004). The authors point out the trade-offs between these two approaches. They find that an organisation that installs a single vendor package may not have all the functionality required, but it will be easier to implement. A multi-vendor solution, which can integrate various modules from different vendors and/or custom software, can provide the best functionality for each module, but implementing the solution becomes more complex because of the interfaces that need to be established (Shehab et al., 2004).

The authors classify the literature based on whether it focuses on selection or implementation (Shehab et al., 2004). According to the authors, most previous ERP research had focused on ERP system implementation and the post-implementation period, while the issues of the acquisition process for adequate ERP system software were mostly ignored.

The authors discuss implementation approaches, and they argue that there are two main strategic implementation approaches: reengineering the business processes to accommodate the ERP system package or customising the software to fit the processes. Furthermore, they discuss linear ERP implementation models. According to Shehab et al. (2004), the scope of ERP implementation encompasses what is often referred to as the entire value chain of the enterprise, from prospect and customer management through order fulfilment and delivery.

The authors do not discuss the top managers' roles or project management explicitly, but implicitly via CSFs such as top management support and effective project management.

3) In their review of 80 publications from 2003 and 2004, Botta-Genoulaz, Millet and Grabot (2005) focused on recent trends in the literature on ERP systems. To structure their analysis, they divided the articles into seven categories: Implementation of ERP systems, Optimisation of ERP systems, Management through ERP systems, The ERP software, ERP and supply chain management and Case studies.

Botta-Genoulaz et al. (2005) referred to the META Group's definition of an ERP system as a suite of enterprise business applications that include at least financial and human resources applications and either SCM (supply chain management) or CRM (customer relationship management) (Hanscome, 2003, as referenced by Botta-Genoulaz et al., 2005). In their discussion of ERP system software, however, the authors pointed to developments such as supply chain coordination across several legal entities and ERP software tools that can support supply chain integration.

As for the implementation of ERP systems, the authors implicitly applied a linear phase model and focused on the post-implementation phase, in which the system is maintained and upgraded. Furthermore, the authors had a broad perspective on implementation, including management and cultural issues in their discussions as well as reasons for success and failures and the systems' impact on organisational performance. However, the authors point to the lack of key aspects such as communication and the role of the steering committee that are not yet fully taken into account during the whole lifecycle of the implementation (Botta-Genoulaz et al., 2005, p. 513; Somers & Nelson, 2004).

During the implementation phase, the authors emphasise the need for companies to appropriately customise both the system and/or the organisation, and they focus on the need for alignment of the standard ERP processes with the enterprise's business processes.

4) Cumbie, Jourdan, Peachey, Dugo and Craighead (2005) reviewed 49 ERP-focused research articles published in top journals from 1999 to 2004. They categorised the articles according to research strategy, year of publication, publications by journal and the focused topics within ERP systems research.

Based on their review of thirteen specific ERP system definitions, the authors (Cumbie et al., 2005) found that the definitions provided "a moderately constant view of ERP as an enterprise wide software solution for integrating data from many functions within the organization operating from a central database to support planning and the flow of information within the organization".

In their analysis, three general areas of ERP system research emerged: ERP implementation, ERP operation and ERP benefits (Cumbie et al., 2005). However, the authors emphasised that the focus areas overlapped and that, for example, benefits might be discussed in the context of implementation. ERP Implementation was defined as the process of integrating an ERP system into an organisation in which no previous ERP system existed. ERP Operations was defined as extending or optimizing the functionality of an ERP system already in place; and ERP Benefits was defined as the impact of implementing and operating an ERP system. The authors found that many field studies using primary data had been conducted on ERP Implementation (57 percent of the articles reviewed), and relatively few field studies using primary data had been conducted on the ERP Operations or ERP Benefits.

With regard to ERP Implementation research, the authors argued that organisational change and business process change are closely linked to IS implementation. Thus, it is difficult to study ERP system implementation and organisational change separately. ERP system implementation issues such as the social aspects of ERP, integration and factors that affect the decision to implement an ERP system were also discussed. Thus, Cumbie et al. (2005) applied a broader perspective on ERP system implementation in their review, than the authors of the prior reviews.

However, the role of top managers and project management were not explicitly mentioned in this review. The researchers maintained that while an ERP system may strengthen an organisation internally, it may also create sub-optimised organisational silos across the extended supply chain. According to Cumbie et al. (2005), "the role of ERP in supply chain integration and the effects of ERP on supply chains is perhaps the biggest area of need for future research efforts".

5) Esteves and Bohorquez (2007) provided an updated annotated bibliography of ERP publications and categorised 640 articles according to the phases in the life-cycle framework provided by Esteves and Pastor (2001) (see review 1 above). They extended the bibliography with 449 publications. Of the 449 publications, 25 were categorised as focusing on Adoption, 15 on Acquisition, 207 on Implementation, 68 on Usage, 59 on Evolution, zero on Retirement, 35 on Education and finally 40 publications were categorised as General: papers not related to the ERP life cycle. Hence, the number of papers related to the implementation phase (47%) was more than three times the size of the next biggest category: Usage.

This review does not discuss the concept of an ERP system. However, they point out that small vendors use the term ERP for systems that have an accounting package, whereas large vendors (SAP and Oracle) keep adding modules and abbreviations (SCM, CRM, etc.) to their traditional ERP systems.

Like the review by Esteves and Pastor (2001), the 2007 review had a life-cycle perspective on implementation, and thus, similarly to the 2001-review, the linear view of the implementation process was continued. Referring to the statement by Esteves and Pastor (2001) that the notion of implementation differed among researchers, Esteves and Bohorquez (2007) claimed that there seemed to be "a consensus for the definition of ERP implementation up to the Go Live of the ERP system". However, the authors did not explain the content of the concept on ERP implementation as it pertained to the Go Live of the ERP system, and they did not explain what they meant by the notion of "Go Live".

The authors (2007, p 393) stated the implementation phase deals with the customisation or parameterisation and adaptation of the ERP package according to the needs of the organisation. Usually this task is performed with the help of consultants who provide implementation methodologies, know-how, and training.

In this review, manager involvement is mentioned in the same manner as the review from 2001, that is, only in the Adoption decision phase questioning the need of an ERP system and in the Retirement phase evaluating substitution with another system. The authors argue (2007, p. 395) that there is a need to create methodologies that help managers to assess why an ERP approach is the most adequate for a specific organisation, and why the current information system should be substituted.

The topic of project management was mentioned twice related to critical success factors and once related to process prototyping. According to the authors, the development of techniques and approaches for the control and monitoring of ERP implementation projects is an area to be improved.

The authors discuss Implementation success that deals with the issues of how to succeed through an ERP implementation. The aspects covered are: ERP project success and failure definitions, problems and outcomes, critical success factors, and risk management. Their findings suggest that research on the identification of critical success factors has reached a saturation point, and that there is little interest in risk factors for ERP implementation projects

(Esteves & Bohorquez, 2007). Furthermore, the authors find that there is a need for more in-depth case studies that document ERP implementations.

6) Moon (2007) reviewed work published in various journals on the topics of ERP systems between 2000 and 2006. A total of 313 articles from 79 journals were reviewed.

The author defined an ERP system as “an enterprise information system designed to integrate and optimise business processes and transactions in a corporation” (Moon, 2007, p. 235).

The literature was analysed according to six major themes. The themes were: Implementation, Using ERP, Extension, Value, Trends and perspectives, and Education. Furthermore, Moon (2007) classified the Implementation articles into five sub-themes: case studies, critical success factors, change management, focused stage and cultural issues. The articles belonging to the focused stage addressed a particular phase of the ERP implementation’s life cycle, such as the ERP system selection process, the customisation of the ERP system, and the configuration of the ERP system. The sub-themes emphasised the organisational perspective of an ERP implementation process comprising organisational change, cultural issues and factors related to the success and failure of the project.

The author described implementing an ERP system as a major project requiring a significant level of resources, commitment and changes within the organisation. Furthermore, he claimed that ERP implementation projects were often the biggest projects that an organisation had ever launched. Therefore, the issues surrounding the implementation project were of major concern.

According to Moon (2007), “the ERP implementation has a life cycle beginning with a company’s decision to go for it to the final go live stage”. Therefore, in line with previous reviews, Moon (2007) saw ERP system implementation as a life cycle. The linear life cycle model was divided into phases until the “go live” stage. Moon did not explain what he meant by “go live”.

More than 40 percent of the articles reviewed belonged to the implementation theme, reflecting the level of importance paid to this issue. Some articles attempted to explain why the ERP implementation was difficult and what needed to be done to achieve desirable results (Moon, 2007). Also, various models of implementation stages and different implementation methodologies were presented. Other topics handled under this theme included project management issues (ibid., 2007). From the reference list, I find that four articles were related to project management issues. Two of them were related to risk management in ERP projects (Huang & Wang, 2004; Sumner, 2000), one article dealt with managing deployment of ERP systems (Huin, 2004), and one article applied and presented a specific project management methodology (Metaxiotis, Zafeiropou, Nikolinakou, & Psarras, 2005).

Metaxiotis et al. (2005) presented the Goal-Directed Project Management (GDPM) methodology based upon layered planning, developed by Andersen, Grude and Haug (2004). The layered planning in this method consists of a milestone plan at the management level and a detailed level outlining the activities and responsibility for achieving a milestone. Separating the big picture from the details is a prerequisite for management to obtain and keep a stable overview of progress and results, at the same time ensuring control at a sufficient level of detail (Metaxiotis et al., 2005; Andersen et al., 2004).

7) Schlichter and Kraemmergaard (2010) provided a comprehensive review of the field of ERP system research. In their review article, abstracts from 885 peer-reviewed journal publications from 2000 to 2009 were analysed according to the journal, authors and year of publication. The publications were further categorised into research discipline, research topic and methods used, as illustrated in Table 2.2.

Table 2.2 Schlichter and Kraemmergaard's (2010) categorisation of publications

Discipline:	Topic:	Method:
- Information systems	- Implementation	- Case study
- Accounting	- Optimisation of ERP	- Archival
- Organisation and management	- Management and ERP issues	- Theoretical
- Operations management (SCM)	- The ERP tool	- Survey
- Computer science	- ERP and supply change management	- Combination
- Other	- Studying ERP	- Design science
	- ERP and education	- Not mentioned
	- The ERP market and industry	- Descriptive/normative
	- Other	- Experimental

Schlichter and Kraemmergaard (2010) referred to the other reviews, except for Moon's (2007). Their review built on the categories for research topics defined by Botta-Genoulaz et al. (2005). However, as summarised in Table 2.2, they extended the categories. Implementation studies were one of the first problems of interest (Botta-Genoulaz et al., 2005) and amounted to 30 percent of ERP research (Schlichter & Kraemmergaard, 2010).

The authors defined an ERP system as: "a business management system that comprises integrated sets of comprehensive software, which can be used to manage and integrate all the business functions within an organisation with a rationalised data architecture characterised by core process integration and shared product and/or customer databases (Ross, Weill, &

Robertson, 2006)". Furthermore, they emphasised the abilities to automate and integrate business processes, enable the implementation of best business practices, share common data and practices across the entire enterprise and produce and access information in real time (Nah & Lau, 2001; Soh, Kien, & Tay-Yap, 2000) to be among the most important attributes of ERP (Schlichter & Kraemmergaard, 2010). In contrast to the reviews by Botta-Genoulaz et al. (2005) and Cumbie et al. (2005), the authors limited the notion of an ERP system to functions within an organisation.

The authors described implementation as how the ERP system could be introduced into the organisation. According to the authors implementation includes system selection, the various steps of implementation and related problems, critical success factors, business process alignment during the implementation and organisational diffusion (Schlichter & Kraemmergaard, 2010). As in the previous reviews, implementation was seen as a linear process.

This review addresses the issue: how the implementation of ERP affects the management. However, the article does not provide direct advice to top managers regarding how to get involved in an ERP system implementation project.

8) Ranjan, et al. (2016, p. 388) "present a review of the current literature published in journals in the field of information system application 'enterprise resource planning' (ERP) to identify challenges faced in ERP implementation projects".

However, the authors did not include a methods section in their paper, and thus the reader is not provided with an insight into how the literature was selected and reviewed. The reference list includes 32 papers published during the period 2008 – 2014.

The authors emphasise that an ERP system enables an organisation to integrate all its primary business processes, and that successful implementation enables an organisation to realise benefits in terms of improved productivity and competitive advantage (Ranjan et al., 2016, p. 389).

Furthermore, the authors (ibid., p. 388) claimed that "ERP implementation is a challenging and expensive task that not only requires rigorous efforts but also demands to have a detailed analysis of such factors that are critical to the adoption or implementation".

In this review, the authors focused on ERP implementation challenges from four different approaches. These approaches were: technology selection, change management, knowledge management and emerging technologies. The authors have a thorough analysis of the literature on ERP system selection challenges. The selection methods and processes still seem to focus on ERP system packages from an organisational perspective. In the emerging technologies section, the authors point to new technologies such as ERP systems as a service and mobile technologies. They also mention extended information system applications. The issues of change management and knowledge management illustrate that the challenges on ERP system implementation are viewed from an organisational perspective, not merely a technological perspective.

9) Ali and Miller (2017) provided a review of ERP system implementation in large enterprises. According to the authors (ibid., p. 670), they reviewed a sample of 215 research papers from the period between 1989 and 2014. However, in the reference list149 items were listed, and among them three papers were from 2015 and one from 2016.

The authors referred to several definitions of the concept of ERP system. Keywords in their discussions of definitions were a central database, packaged software and integration. The most comprehensive definition cited is the definition by Štemberger and Kovacic (2008) who defined an ERP system as a “packaged business software system that enables companies to effectively and efficiently manage resources (material, human resources, finance, etc.) by providing a total integrated solution for an organisation’s information-processing needs” (Ali & Miller, 2017, p. 668). Thus, Ali and Miller still consider ERP system software as packaged.

According to Ali and Miller (2017, p. 672), “ERP implementation is the process through which technical, organisational, and financial resources are configured to provide an efficient operating system (Fleck, 1994)”.

The authors mentioned several times (Ali & Miller, 2017, e.g. pp. 666, 675) that they classified their review according to the ERP lifecycle framework developed by Esteves and Bohorquez (2007), see review 5 above. However, the authors did not present the framework by Esteves and Bohorquez, but focused on a three-phase implementation process: pre-implementation, implementation and post-implementation, that is, a linear implementation model. The phases of pre-implementation and post-implementation were not defined. However, in their review of the implementation phase, the authors referred to linear models that comprise pre- and post-implementation phases, for example, the model by Markus and Tanis (2000) that I will present below.

In addition to implementation models, the authors discussed strategies in the implementation phase, but the term implementation strategy was not defined. However, the discussion of strategies seems to comprise activities that mainly belong to the pre-implementation phase, such as planning for resource availability and exploring standard ERP system functionalities (ibid., p. 677). Thus, the authors do not have clear definitions of the phases involved in an implementation process.

In a discussion of ERP system implementation failures, the authors (ibid., p. 680) stated that the most common cause was a combination of poor planning and high customisation of ERP software. They maintained that the three most important critical success factors are "top management support, good project teams, and good communications" (ibid., p. 682), but the factors were not described in detail.

2.2 Part II – review of the ERP system implementation research

In part II of this review, I discuss the concept of an ERP system. Thereafter, I discuss implementation models, the concept of ERP system implementation and generic Critical Success Factors (CSFs). Finally, a critical assessment of the ERP system implementation literature points to gaps in the literature that I will contribute to fill with my thesis.

2.2.1 The concept of an ERP system

As demonstrated in the review articles, the concept of the ERP system has developed. At the start of the century the concept was related to packaged software as illustrated by Esteves and Pastor (2001), who defined ERP systems as "software packages composed of several modules, such as human resources, sales, finance and production, providing cross-organization integration of data through embedded business processes".

The development of standardised interfaces among packages and modules changed this picture. This development facilitated various vendors' technical composition of ERP system modules and integrated those modules across organisational borders. As explained by Shehab et al. (2004), "an ERP "solution" can be put together in a number of ways. At one end, an organisation can install a single vendor package. At the other end, it can integrate different modules from different vendors and/or custom software for a 'best of breed' (BoB) solution". Furthermore, Botta-Genoulaz et al. (2005) discussed ERP systems' ability to support supply chain integration.

In accordance with this development, in this thesis, the term "ERP system" refers to computer-based information systems that have the potential to help managers integrate their operations and exchange of goods, services, payments and data with their customers and suppliers. The modules and sub-systems in ERP systems often represent business functions such as finance, sale, planning and production. The processes can be integrated across functional borders.

With an ERP system, data are automatically updated and accessible throughout the business as soon as they are confirmed. For example, entering an order into a production enterprise's ERP system will generate messages and requests throughout the extended supply chain. The interaction among numerous interdependent elements has a potential to results in high levels of process integration (Park & Kusiak, 2005).

The standardised and integrated ERP system software provides a degree of interoperability that is difficult and expensive to achieve with tailored standalone systems (see, Gattiker & Goodhue, 2005; Hitt, Wu, & Xiaoge, 2002; O'Leary, 2000). Before ERP system packages were available in the market, department managers purchased or developed standalone systems to support their specific needs. The standalone systems usually did not have a common interface facilitating the automatic transfer of data from one module to another. Therefore, without a common interface among standalone systems, people often had to establish manual procedures to transfer data between systems. ERP system packages were and are developed for the purpose of integrating business data, and therefore it is often an advantage, if possible, to use an ERP package as a starting point when planning the development of an ERP system.

ERP systems can replace multiple incompatible standalone systems by integrating data from all parts of the organisation (see, e.g., James & Wolf, 2000; Robey et al., 2002; Turban, McLean, & Wetherbe, 2002). With an integrated ERP system in place, manual transfer of data among systems is redundant. Organisational integration is the extent to which distinct and interdependent components constitute a unified whole (Barki & Pinsonneault, 2005). One of the defining characteristics of ERP systems is the extensive integration the system provides among the subunits of a business (Gattiker & Goodhue, 2005).

The ERP system packages represent best practices work processes (i.e. the best way of doing business). Therefore, when the use of ERP system packages becomes common they are necessary to avoid being left behind. According to Shehab et al. (2004), an ERP system can be put together in a number of ways and they distinguish between a single-vendor solution and a multi-vendor solution. The authors stated that the multi-vendor solution may include custom-made software and that this makes implementation of the solution more complex because of the necessary integrations that need to be established (ibid., 2004).

2.2.2 The concept of ERP system implementation

As documented in Part I, the literature on ERP system implementations focuses on linear implementation models to gain a deeper understanding of the implementation processes and to provide advice for successful implementation. Some models organise the implementation process into phases.

The number of phases varies among the articles, as do the naming and content of the phases that the researchers apply. Furthermore, the models vary regarding when the implementation process starts, and when it ends. Thus, there is no agreed-upon model for ERP system implementation. However, the implementation models I have found in the ERP system literature portray a linear view of the implementation process. Examples of three often cited linear implementation models and their phases are illustrated and explained next.

The first linear implementation model was developed by Bancroft, Seip and Sprengel (1998) and is illustrated in Figure 2.1. The model and its pertaining phases are explained below the figure.

Focus	As is	To be	Construction and testing	Actual implementing

Figure 2.1 Linear model by Bancroft et al. 1998

This model has five phases, and it starts with the planning phase termed Focus in which the steering committee is established, project team members are selected, and a project plan is developed. The "As is" phase involves modelling and analysis of current business processes. The "To be" phase involves design and prototyping in collaboration with users. The "Construction and testing" phase implies the configuration of the software, building and testing interfaces, system and user testing. Finally, the "Actual implementation" phase covers building networks, installing desktops and managing user training and support.

The model provided by Bancroft et al. (1998) covers the phases from the establishment of a project until a delivery of the system is made. The model focuses on the project activities necessary to develop and deploy the technical ERP system. However, Bancroft et al. (1998) did not include system use and system improvements in their model.

Ross and Vitale (2000) compared the ERP system implementation process to the journey of a prisoner escaping from an island prison. Their model is illustrated in Figure 2.2 and explained below.

Design	Implementation	Stabilisation	Continuous improvement	Transformation

Figure 2.2 Linear model by Ross and Vitale (2000)

In their research, Ross and Vitale (2000) described five stages of ERP system implementation. The phases were: ERP design (the approach), implementation (the dive), stabilisation (resurfacing), continuous improvement (swimming) and transformation. The authors used the term implementation to describe both the entire process including all five steps and to describe the particular Implementation phase between the Design and Stabilisation phase.

Ross and Vitale (2000) noted that the new system implied new processes. Hence, it was not possible to implement (i.e., deploy) the new system and the new processes separately because they were highly interdependent.

In the stabilisation phase, the authors found empirical evidence for underperformance just after deployment, when the firm and its processes and data had to adjust to new circumstances. This period was called a "performance dip", and it is illustrated in Figure 2.3.

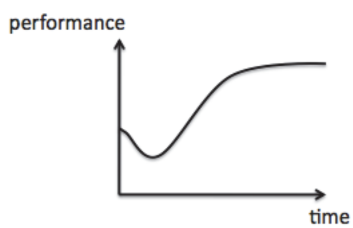


Figure 2.3 Illustration of a performance dip

Ross and Vitale (2000) did not discuss the role of top managers, steering committee or project managers during the ERP system implementation process.

A much cited model, developed by Marcus and Tanis (2000) is illustrated in Figure 2.4. In their model the authors provide a substantial amount of advice to managers and therefore, I describe this model in more detail than the two previous models.

Project chartering	The project (configuration & rollout)	Shakedown	Onward and upward

Figure 2.4 Linear model by Marcus and Tanis (2000)

Marcus and Tanis (2000) set out to "shed light on the questions facing the executive leadership of an organization considering whether, why, and how to participate in the enterprise system experience and what to do at various points in the process".

Marcus and Tanis (2000) divided their model into four phases: *Project chartering*, *the Project* (configuration and rollout), *Shakedown* and *Onward and upward*. This model was later applied by a number of researchers investigating ERP system implementations (Kumar, Maheshwari, & Kumar, 2002; Nah, Lau, & Kuang, 2001). The authors described the chartering phase as the phase that comprises decisions leading up to the funding of an enterprise system. Key players in this phase included vendors, consultants, company executives, and IT specialists, although the precise constellation of players may vary. The authors emphasised some key activities in the chartering phase including building a business case, selecting a software package (though this decision may be deferred until the project phase), identifying a project manager, and approving a budget and schedule. The outcome of this phase may be a decision to proceed with the enterprise system or a decision not to proceed.

Thereafter, the project phase comprises activities intended to get the system up and running in one or more organisational units (ibid., 2000). Key players in this phase included the project manager, project team members, internal IT specialists, vendors, and consultants. Furthermore, key activities included software configuration, system integration, testing, data conversion, training, and rollout. The authors pointed out possible outcomes of the project phase. They claim that for some organisations the result may be the rollout of an enterprise system to one or more units. However, some projects are terminated owing to cost or schedule overruns or severe technical problems.

The shakedown phase starts with "going live" and continues until "normal operation" has been achieved (or the organisation gives up, disinstalling the system) (ibid., 2000, pp. 193, 195). In this phase, "the project (or consulting) team may continue its involvement or may pass control to operational managers and end users and whatever technical support it can muster" (ibid., 2000, p. 295). Furthermore, the authors emphasise activities such as bug fixing and rework, system performance tuning, retraining, and staffing up to handle temporary inefficiencies as pertaining to the shakedown phase. They point out, that to a large extent, this is the phase in which the errors of prior phases are felt, in the form of reduced productivity or business disruption.

Finally, the onward and upward phase continues from normal operation until the system is replaced with an upgrade or a different system. According to the authors, key players in this phase include operational managers, end users, and IT support personnel (internal or external). Vendor personnel and consultants may also be involved, particularly when deliberations about upgrades are concerned. Furthermore, they emphasise some characteristic activities of this phase, such as continuous business improvement, additional user skill building, and post-implementation benefit assessment. Marcus and Tanis (2000) point out that benefits (if any), of the investments, are realised during the onward and upward phase.

According to the authors, different actors are involved in different phases. For example, company executives play a key role in the project chartering phase, which is the phase in which decisions leading up to project approval and funding are taken. Furthermore, an executive steering committee provides oversight during the project phase.

In addition, the authors argued that problems might occur in all phases and that many problems experienced in later phases might have originated earlier but remained unnoticed or uncorrected. In their review article, Shehab et al. (2004) added that these findings suggest that managers should pay particular attention to the early identification and correction of problems.

The models presented in this section assume a linear implementation process. They all include phases that contain planning activities followed by execution activities. Bancroft et al. (1998) include three planning phases in their model (Focus, As-is and To-be), followed by two execution phases (Construction and testing, and Actual implementation). In the two latter models, the planning phases "Design" (Ross & Vitale, 2000) and "Project chartering" (Markus & Tanis, 2000) are followed by the execution phases "Implementation" (Ross & Vitale, 2000) and "Project" (Markus & Tanis, 2000). Furthermore, in the two latter models, the execution phases are followed by consecutive phases describing system use and development.

The model by Bancroft et al. (1998) and the model by Marcus and Tanis (2000) draw on the project management approach in their models. Both models focus on the roles of the steering committee, project manager and project teams in their implementation models. In addition, Bancroft et al. (1998) emphasise project activities such as the development of a project plan, business process mapping and testing of software and interfaces. However, Bancoft et al. (1998) do not include a phase for system use and development in their model.

Compared to Bancroft et al. (1998), both Ross and Vitale (2000) and Marcus and Tanis (2000) have a broader perspective on implementation because they include phases in which the project results arise and thus help to maintain focus on the objectives throughout the project. Furthermore, including phases for system use and improvements emphasise the planning and preparation activities that are necessary to use and develop further the system as intended.

At the beginning of the century, the focus of the implementation was on the selected software package and the adaptation of the business to the "best practices" represented in the package

(Davenport, 1998). Volkoff (1999) stated: "The central challenge of an ERP implementation is the adaptation process that brings an organization's existing operating processes and the software's embedded functionality into alignment".

The development of standard interfaces among system modules shifted the focus of implementation projects towards selecting the "best of breed" system modules and taking care of or developing competitive advantages that exploited the potential of the new technology. The development of standard interfaces also facilitated the integration of custom-made modules with commercially developed software packages.

Furthermore, as illustrated in the reviews, the implementation process shifted from a focus on technical adaptation (Esteves & Pastor, 2001) to an organisational change process involving cultural factors (see, Botta-Genoulaz et al., 2005; Moon, 2007) and emerging technologies (Ranjan et al., 2016). However, even the latest reviews referred to linear implementation models, but as discussed in the previous section, the phases of the models varied both with regard to the planning of the implementation project, the use of the system and evaluation of the results.

In this thesis, I will apply the broad view on implementation provided by Lucas (1981, p. 14). He defined implementation of information systems as "an ongoing process which includes the entire development of the system from the original suggestion through the feasibility study, systems analysis and design, programming, training, conversion, installation and evaluation of the system". Lucas's definition states when the implementation process starts, when it ends and what comes in between. In my study, the implementation process starts when managers uncover a gap between the current and desired situation, and the process continues until the ERP system is either used as intended or found inadequate and discarded.

2.2.3 Generic CSFs related to ERP system implementation

Some ERP system projects are considered successes, while others are seen as total failures. This fact is documented through numerous reports on failed projects which have even been known to lead to organisational bankruptcy (Davenport, 1998; Markus & Tanis, 2000; Moon, 2007; Shehab et al., 2004). For example, Moon (2007) claimed that numerous failed ERP system implementation projects exist, including a few fatal disasters which led to the demise of some companies.

The implementation of ERP systems continues to challenge managers. Managers need advice on how to manage implementation projects. Therefore, research is needed to help practitioners to enhance their understanding of how ERP systems can be implemented successfully, that is, in order to attain organisational goals.

CSFs have been subject to intensive literature reviews (Botta-Genoulaz et al., 2005), and the amount of research focusing on CSFs during implementation is comprehensive. Rockart (1979, p. 85) defined CSFs as "the few key areas where "things must go right" for the business to flourish". In the comprehensive literature on CSFs for ERP system implementation, the authors attempt to explain successes and failures of implementations to help managers handle the challenges of ERP system implementation. Based on a comprehensive review, Finney and Corbett (2007) found the list of CSFs shown in Table 2.3. The authors also listed the number of instances each factor had been cited in the literature, as shown to the right in the table.

Table 2.3 Frequency analysis of CSFs in literature (Finney & Corbett, 2007)

CSF category	Number of instances cited in literature
Top management commitment and support	25
Change management	25
BPR and software configuration	23
Training and job redesign	23
Project team: the best and brightest	21
Implementation strategy and timeframe	17
Consultant selection and relationship	16
Visioning and planning	15
Balanced team	12
Project champion	10
Communication plan	10
IT infrastructure	8
Managing cultural change	7
Post-implementation evaluation	7
Selection of ERP	7
Team morale and motivation	6
Vanilla ERP	6
Project management	6
Troubleshooting/crises management	6
Legacy system consideration	5
Data conversion and integrity	5
System testing	5
Client consultation	4
Project cost planning and management	4
Build a business case	3
Empowered decision makers	3

The number of CSFs varied among the articles, as did the factors that the researchers considered critical to the success of ERP system implementation. Thus, there is no set of agreed-upon critical success factors for ERP system implementation. For example, Finney and Corbett (2007) did not include the factor "effective communication", which is mentioned as critical in several other papers (see, e.g., Bhatti, 2005; Nah & Lau, 2001). In this thesis, effective communication means that a person (sender) conveys a message to another person (receiver), and that the receiver understands the message as intended (Shannon & Weaver, 1949). Finney and Corbett (2007) listed the factor "communication plan". However, there are differences between having a communication plan and communicating effectively. Also, Table 2.3 does not include the factors "user participation" and "user involvement", which are considered essential in the IS development literature (see, e.g., Barki & Hartwick, 1994; Elstad, 2014; Kujala, 2003; Swanson, 1988).

As indicated in Table 2.3, *top management commitment and support* is the factor mentioned most frequently. Furthermore, it is the factor mentioned as the most important success factor in ERP system implementation projects (see, e.g., Bhatti, 2005; Elstad, Fuglseth, & Grønhaug, 2009; Somers & Nelson, 2001). However, authors have described the factor differently in the literature. Some authors emphasise the top managers' formal authority, for example, Slevin and Pinto (1987, p. 34): *"Willingness of top management to provide the necessary resources and authority or power for project success"*. Other researchers include comprehensive demands on the top managers' involvement in ERP system implementations, for example Al-Mashari, Al-Mudimigh and Zairi (2003): *"Not only is the requirement for setting the vision and the direction for the business, it is also for harnessing the energy and creativity of employees, for enabling the business to perform, for implementing modern concepts ... and for exploiting the technology capabilities of an ERP system"* (Al-Mashari et al., 2003, p. 356). According to some authors, the top managers must be involved in every step of the ERP implementation, see, for example Al-Mudimigh, Zairi, and Al-Mashari (2001); Bingi, Sharma and Godla (1999); Nah et al. (2001).

As many of the authors have emphasised, it is the top managers' responsibility to stake out the course for the organisation. They have the authority and responsibility to decide the development of the organisation, including the power to allocate resources to the ERP system implementation project. However, the description of the factor *top management commitment and support* does not explain, for example, *how* top managers can harness the energy and creativity of employees, and *how* they should be involved in every step of the ERP project.

A review by Elstad, Fuglseth and Grønhaug (2009) shows that the current literature of CSFs for implementation of ERP systems provides little advice to managers about how to lead organisational change projects involving enterprise systems. According to the authors "definitions of factors are usually rather abstract, and there is little practical advice to managers about how to handle each factor to attain 'success'." (ibid., p. 156)

Sarker and Lee (2003) conducted a case study to test the criticality of three frequently mentioned critical success factors. The factors were “strong and committed leadership”, “open and honest communication”, and “a balanced and empowered implementation team”. They found that while all three factors might contribute to project success, only “strong and committed leadership” could be empirically established as a necessary condition (Sarker & Lee, 2003).

As indicated in Table 2.3, “project management” is among the most cited CSFs. Finney and Corbett (2007) found six instances of this CSF. However, the authors included several additional factors related to project management, such as: building a business case, visioning and planning, balanced project team, communication plan and project cost planning and management. Hence, the CSF literature indicates that project management is one of the most critical factors in any ERP system implementation project, but does not provide the necessary advice or insights into how managers ought to perform project management when implementing an ERP system.

The only paper I found presenting a project management methodology was the case study by Metaxiotis et al. (2005). In this study, the authors found that the GDPM (Goal-Directed Project Management) methodology was able to control and reduce the time and the cost of implementation (ibid., 2005, p. 55). However, in the study, the vendor applied the methodology in a vanilla implementation of an ERP system package. Hence, the methodology was not applied by business managers in an implementation project comprising, among others, the evaluation and selection of the software and preparing the organisation for the new technology.

Table 2.3 indicates the tendency mentioned in the section above on the concepts of ERP system and implementation, that the discussions are mostly related to implementation of ERP system packages, cf. the CSFs “selection of ERP” and “vanilla ERP”. According to Finney and Corbett (2007), implementing the vanilla version (i.e. avoiding customisation) of the ERP system is a frequently mentioned critical success factor in the literature. Authors have even suggested that customisation of an ERP system is among the major reasons for implementation failure (Shehab et al., 2004).

Some researchers give advice regarding how to avoid complexity in ERP systems by minimising customisation. Among them, Ali and Miller (2017, pp. 677-678) argue that a common approach to avoid the complexities of realignment and customisation, involves selecting only the “best” modules within an ERP system, that is, modules that match the business processes. Examples are human resources, accounting and inventory management.

2.3 Positioning of my research

In this section, I will position my study, based on the literature review above. First, I argue for the need to study customisation of ERP systems. Thereafter, I argue that the linear approach may not be adequate in the management of complex ERP system implementation projects. Furthermore, I point out the lack of integration of agile methods from the project management literature into the ERP system implementation literature. Finally, I argue for studies that emphasise the top managers' role in the ERP system literature.

2.3.1 The ERP system

Based on the review articles reviewed in part I, I find that the view of ERP systems as packages is still prevalent. For example, according to Ali and Miller (2017), an ERP system is a "packaged business software system".

In spite of the development of standard interfaces to facilitate the integration of modules, I found that only a few articles mentioned the possibility of customisation of ERP system modules, and that the articles that mentioned customisation did so in order to advise against it. In particular, the CSF literature related to ERP system implementations provides the advice to minimise customisation (see, e.g., Finney & Corbett, 2007; Nah & Lau, 2001; Somers & Nelson, 2004).

However, in my view, managers need to assess their work processes and to be particularly attentive to the work processes where they may have competitive advantages. To maintain a competitive advantage, it may be necessary to customise ERP system modules to support business critical processes.

In my thesis, I will analyse the implementation of an ERP system involving the design, development and deployment of custom-made modules.

2.3.2 Complexity in ERP system implementation projects

As stated in the introduction, several authors describe ERP system projects as complex (Ferratt et al., 2006).

However, the meaning of the concept of project complexity is not defined. According to Baccarini (1996, p. 201), project complexity can be defined as "consisting of many varied interrelated parts". In other words, he operationalised the concept in terms of differentiation and interdependency. Baccarini (1996) discussed complexity as it pertained to construction projects, but his discussions are relevant to ERP system projects as well, because both ERP system projects and construction projects involve organisational and technological complexity.

Organisational complexity by differentiation refers to the number of hierarchical levels involved in the project (vertical differentiation) and the number of units and tasks concerned (horizontal differentiation). Organisational complexity by interdependency refers to the degree of operational interdependencies and interaction among the organisational elements. Technological complexity by differentiation refers to aspects of a task, such as the number and diversity of parts and actions, involved in handling the task. Technological complexity by interdependencies can encompass interdependencies among tasks, networks of tasks, teams and different technologies.

Applying Baccarini's definition (Baccarini, 1996), ERP system projects can be characterised as organisationally complex because they involve both the operational and the tactical level of an organisation, as well as the whole supply chain. The projects can be characterised as technologically complex because they encompass numerous tasks, parts and actions with dependencies among the various tasks, project teams, specialists and technological components.

As mentioned by Shehab et al. (2004) (review 2), the complexity of an implementation project increases when the project involves modules from several vendors and custom-made modules. In addition, according to Marcus and Tanis (2000, p. 203), organisations with many subunits face chartering and project complexities that single-location businesses do not. Therefore, when complexity and uncertainty are high the implementation process does not necessarily comply with the linear models predictions or recommendations. Still, linear implementation models are recommended.

The ERP system literature provides little help to managers regarding if and when the linear implementation models are appropriate. Furthermore, this literature provides little advice regarding alternative approaches that might be appropriate in situations where the linear approach does not apply.

For example, in contrast to the linear approach, an iterative approach recognises the considerable amount of interdependence and interactivity between modules, projects, sub-projects, project levels and project phases, where organisational change and process innovation take place. Hence, the iterative approach recognises the complexity involved in ERP system implementations. Therefore, there is a need for studies investigating ERP system implementations projects, applying iterative implementation approaches.

In my thesis, I will investigate if and how the managers' decisions to apply a linear or iterative implementation approach may have influenced the project result. Furthermore, I will evaluate if and how their decisions regarding choice of implementation approaches may have influenced organisational effectiveness. Thus, I will enhance the understanding of appropriate use of linear and iterative implementation approaches in complex ERP system implementation projects.

2.3.3 Project management

The ERP system literature, and in particular the CSF literature, emphasise project management as a critical factor in ERP implementation projects (Finney & Corbett, 2007; Nah & Delgado, 2006; Ngai, Law, & Wat, 2008). As mentioned above, Finney and Corbett (2007) found that *project management* was among the most cited CSFs in the literature. However, in the CSF literature I found few attempts to explain in detail how managers should manage their projects. Furthermore, few references were made to project management methodologies that could provide managers with detailed advice regarding how to build a business case, establishing a balanced project team, developing a communication plan, etc.

Despite the complexity involved in ERP system implementation projects, the project management literature is only to a small degree incorporated into the ERP system literature. Therefore, I present a project management methodology as my conceptual framework in Chapter 3 of my thesis.

I assume that a project management methodology, such as the one I present in Chapter 3, is helpful to both researchers and managers to better understand how to manage complex projects. Therefore, based on my conceptual lenses I analyse project management in a complex ERP system implementation project, and I assess if and how decisions related to project management may have influenced the project result and organisational effectiveness. Thus, I will enhance the understanding of how to manage complex implementation projects, such as an ERP system implementation project, to increase organisational effectiveness.

2.3.4 The top managers' role

The top managers are frequently mentioned in the literature, usually in studies investigating critical success factors or in studies referring to the CSF literature. This body of literature describes some CSFs as particularly critical and among them numerous studies point to top management commitment and support as one of the most important critical success factors, related to ERP system implementations (see, e.g., Esteves & Bohorquez, 2007; Finney & Corbett, 2007; Shehab et al., 2004).

Still, few studies have examined the role of the top management or the steering committee in detail, and the literature provides little advice to top managers regarding how to get involved in

ERP system implementation projects in a way that may influence the project result and subsequently influence organisational effectiveness.

In the studies conducted so far, the advice to top managers regarding how and when to get involved in the ERP system implementation process is scarce. Thus, my literature review revealed a need for in-depth empirical studies of top managers' involvement in the ERP system implementation process.

An ERP system implementation spans the entire organisation, and only the top managers are authorised to make necessary decisions affecting the entire organisation. Therefore, in this study I will evaluate the top managers' involvement in the ERP system implementation project and evaluate how their involvement may influence the project result and furthermore, how their involvement may influence organisational effectiveness.

3 Conceptual framework

Implementations of ERP systems are usually organised as *projects* (Ghosh & Skibniewski, 2010). However, ERP system implementation is not merely an organisational change project, but an organisational change project that involves the adaptation and/or development of a complex technological system. Furthermore, the authors argue that, “adopting and implementing appropriate project management principles, tools, and techniques to manage large and complex application projects is one of the most important management decisions for managing any enterprise application implementation” (ibid., p. 534).

As accounted for in the literature review, project management is not adequately incorporated into the ERP implementation literature. Therefore, as a conceptual framework for my thesis, I will draw heavily on the acknowledged and widespread project management standard provided by the Project Management Institute (PMI) and the project management literature related to software development.

In this chapter, I start with a brief account of the development of the project management discipline. Thereafter, I describe the five project management process groups and nine project management knowledge areas presented in the PMI literature (PMBOK®, 2008) . Furthermore, I discuss approaches to software development and the appropriate application of the various approaches.

3.1 Development of the project management discipline

The project management discipline developed, among others, from constructions raised by civilians and soldiers (Cleland & Gareis, 2006). One of the key figures who influenced the field of project management is Henry Fayol (1841-1925). He presented five principles of management that constitute the basis for the body of knowledge in modern project management (Witzel, 2003). The principles (or activities) are planning, organising, management, coordination and control (feedback).

Henry Gantt (1861-1919) focused on two of the activities emphasised by Fayol – planning and control. According to Stevens (2002), Gantt is referred to as the father of planning and control techniques. He developed the Gantt chart, which utilises bars to demonstrate a project’s elements. Gantt charts continue to be an important project management tool. For example, Gantt charts are utilised in Microsoft Project software.

In the 1950s, managers began to approach complex engineering projects with project management tools and techniques such as a scheduling methodology (Kwak, 2005). At that time, milestone planning was introduced to the field of project management through the development of PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method). Both PERT and CPM are used to coordinate activities that contribute to the completion of a project. The milestone scheduling quickly spread into a number of enterprises as it helped managers to direct projects towards their goals. The concept of the milestone and the PERT and CPM techniques are further explained later in this chapter.

Engineering projects (e.g. construction projects) are particularly prominent in the literature (Andersen et al., 2004). Another type of project is the event project, which includes both planned and unplanned events. An example of a planned event is a sports event. Handling a natural disaster is an example of an unplanned event. An event project involving an unplanned event is also called a crisis management project. Since the 1950s, information system (IS) projects have become a global phenomenon, as have engineering and event projects (Andersen et al., 2004). Among IS projects, a project involving the implementation of an ERP system is considered one of the most difficult challenges for managers (Karimi, Somers, & Bhattacherjee, 2007; Uwizeyemungu & Raymond, 2009).

In 1969, the Project Management Institute (PMI) was founded. This institute has proposed a set of standards and practical guidance for project management. These standards and guidelines are incorporated in a document known as PMBOK® (*Project Management Body of Knowledge*), which defines the fundament of project management knowledge. According to the PMI institute, in 2017, nearly three million people worldwide were members and certified professionals (*PMI - annual report* 2017). To obtain certification recognised by PMI, one must pass a rigorous exam based on the PMBOK® standard. In this thesis, I heavily depend on the PMBOK®, Fourth Edition (2008) and Fifth Edition (2013) provided by PMI, for my understanding of what constitutes project management.

3.2 Project and project management

The Project Management Institute (PMI, 2019) defines a project as a temporary endeavour undertaken to create a unique product, service or result. Furthermore, Gido, Clements and Clements (2014) define a project as an endeavour to accomplish a specific objective through a unique set of interrelated tasks and the effective utilization of resources.

In this thesis, I build on the two prior definitions, defining a project as a temporary organisation undertaken to create a unique product, service or result, through the effective utilization of resources. Thus, I have adopted the definition provided by PMI and extended it with the claim from Gido et al. (2014), which emphasises the effective utilisation of resources.

In the project management literature, a distinction is made between the base organisation and the project organisation (Kolltveit, Reve, & Lereim, 2009). A project organisation is a temporary organisation that is established to manage the project. A project organisation has a manager and personnel resources in addition to financial and other resources, such as equipment and offices. The base organisation is the organisation that does not include the project organisation.

As opposed to the base organisation, a project organisation is *temporary* in that it has a defined beginning and end, and therefore defined scope and resources (PMI, 2019). Top managers in the base organisation establish a temporary project organisation to provide a delivery to the base organisation. The effects deriving from a project are expected to be exploited in the base organisation. Therefore, the result created by the project is not temporary, as most projects are undertaken to create a long-lasting result (PMI, 2019) in the base organisation.

A project is *unique* in that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal (PMI, 2019). Therefore, a project requires resources from different parts of the base organisation at different points in the project time span. Consequently, people who do not usually work together often comprise a project team. Furthermore, the claim that a project is unique implies that it always involves uncertainty and a certain risk of failure.

As stated earlier, project organisations are established to create a unique product, service or result, required by the base organisation. Hence, the *project goal* is related to the delivery of a specific product or service to the base organisation. The managers in the base organisation intend to utilise the delivery to gain some effects. Therefore, I distinguish between project goals and effect goals (Andersen et al., 2004). By project goals, I mean the delivery of a unique product or service to the base organisation. By effect goals, I mean the project's long-term effects on the base organisation.

The project organisation is established to produce a result that it then delivers to the base organisation. The project is defined as a success if it results in achieving the project goal within the specified time and budget limitations. The base organisation receives the result of the project and is responsible for the effective use and realisation of planned effects. Hence, the base organisation is responsible for early operational benefits and long term benefits resulting from the project deliveries.

In this thesis, I apply the project management model developed by the Project Management Institute. This model accounts for an iterative approach to project management that guides managers in their management of complex ERP system implementation projects.

The model consists of five PM process groups and nine PM knowledge areas that are necessary for effective project management. According to PMBOK® (2008), the PM process groups and PM knowledge areas are the core technical subject matters of the project management profession. In total, 42 project management processes are embraced in the PMBOK®. In Table 6, these processes are mapped into a matrix in which the PM process groups constitute the columns, and the PM knowledge areas constitute the rows.

The five PM process groups are illustrated in Figure 3.1 and described below:

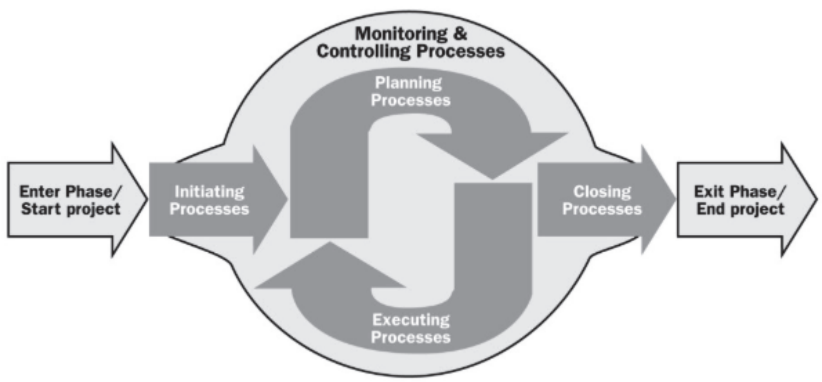


Figure 3.1 The PMI Project management model

1. Initiating process group: The initiating process group consists of those processes performed to define a new project or a new phase of an existing project by obtaining authorisation to start the project or phase (PMBOK®, 2013). Within the initiating processes, the project charter is developed, stakeholders are identified, and the initial scope and other framework conditions are indicated. The project charter builds on the business case that is developed prior to the initiating phase. The project owner is responsible for the development and approval of business case and project charter documents.

2. Planning process group: The planning process group consists of those processes required to establish the entire scope of the project, refine the goals from the project charter, and mark out the course of action required to attain those goals (PMBOK®, 2013). The planning processes develop the project documents that will be used to carry out the project, such as the milestone plan, activity plans and responsibility charts. The

planning processes may be iterative, implying that they may require additional analysis and re-planning as more information or requirements are gathered and understood.

Andersen et al. (2004) recommend that a project plan be divided into two levels, the general level and the detailed level. At the general level, a milestone plan provides an overview of the project by emphasising the milestones. The milestones are important states or check points that a project undergoes on its path to accomplish its goals.

On the detailed level, the activity plan specifies the activities that the project members plan and execute to accomplish the milestones. An activity plan is necessary to manage the activities planned and executed. The activity plan provides detailed insights into how the milestones are going to be achieved, which is useful to the project members and the project manager in the day-today management of a project. In addition, a responsibility chart is needed to keep track of who is responsible for the activities and the milestones in the project plan.

A milestone plan serves the general level because it is stable (rarely changed) and therefore appropriate for communication with stakeholders who do not possess detailed information about the project. For example, managers often do not have the time or the competence to engage with all the detailed plans and activities in sub-projects. Hence, the milestone plan enables managers to maintain overview, monitor the progress, and detect problems and deviations at a general level, without necessarily having a detailed knowledge of the activity plans.

3. Executing process group. The executing process group consists of those processes performed to complete the work defined in the project management plan to satisfy the project specifications (PMBOK®, 2013). This process group involves coordinating and performing the activities of the project. Furthermore, the execution phase requires updated needs assessment, development and management of the project team and the management of stakeholder expectations. During project execution, deliveries may require changes that are likely to mandate updated project documents and re-planning. These changes may also call for updates related to the project scope, activity scheduling, financial requirements, human recourse requirements, and risk assessments.
4. Monitoring and controlling: The monitoring and controlling process group consists of those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes (PMBOK®, 2013). In this process group, project performance

is reported and evaluated at regular intervals. The project team members report to the project manager. In regular meetings they report progress related to detailed activity plans. The project manager reports to the steering committee. In regular meetings, the project manager reports progress made on an approved milestone plan. In both meetings, the state of affairs is presented, appropriate handling of possible deviations are discussed, necessary decisions are made and the further course of the project is marked out.

5. Closing processes: The closing process group consists of those processes performed to finalise all activities across all project management process groups to formally complete the project, phase, or contractual obligations (PMBOK®, 2013). This process group verifies that all other process groups complete the defined processes that close the project or a project phase. The responsibility of the steering committee during this process group is to establish that the project or project phase is completed. Each time a project phase is closed the steering committee must assess and determine whether the project ought to proceed to the next phase. Note that the PM process groups are not project phases. As projects are separated into distinct phases and/or sub-projects such as feasibility study, concept development, design, build, test and deployment, each of the process groups would normally be repeated for each phase or sub-project (PMBOK®, 2013).

In addition, the model focuses on the requirements for entering a project or a new project phase and for ending a project or a project phase. Hence, this model recognises that complex organisational change efforts, such as an ERP system implementation, are usually organised as projects. The steering committee authorises the project to start and to progress from one phase to the next, based on the information provided by the project manager. The steering committee also authorises the closure of a project and a project phase.

Furthermore, the steering committee has the responsibility of deciding if a project that exceeds its cost limits deserves more resources or termination.

In the following section, I will briefly describe the nine knowledge areas:

Project integration management includes the processes and activities needed to identify, define, combine, unify and coordinate the project management processes mapped in Table 3.1.

Management of the area implies making decisions about resource allocation, trade-offs among objectives and requirements and the management of interdependencies among the project management knowledge areas (PMBOK®, 2008).

The project organisation is delegated a certain power to perform the task. The top managers' job is to establish the project organisation, delegate power and allocate resources.

Project scope management includes the processes required to ensure that the project includes all the activities required, and only the activities required, to complete the project according to the project goals. Thus, this management area is primarily concerned with defining and controlling what is and what is not included in the project.

Project cost management includes the processes involved in estimating, budgeting and controlling costs to complete a project within the approved budget (PMBOK®, 2008).

Project time management includes the processes required to manage the project within the timeframe conditions (PMBOK®, 2008).

Project quality management includes continuous process improvement, which is an iterative means for improving the quality of all processes to reduce waste and to eliminate activities that do not add value. Hence, this knowledge area is meant to increase effectiveness (PMBOK®, 2008).

Quality planning must be coordinated with the other project planning processes. For example, if a software change is requested to meet quality requirements, this alteration is likely to require updates in the plans concerning scope, scheduling and budgeting.

Table 3.1 Project management activities pertaining to Project management process groups and PM knowledge areas

PM knowledge areas:	Project management process groups				
	Initiating process group	Planning process group	Executing process group	Monitoring & control process group	Closing process group
Project integration management	1.1 Project charter development	1.2 Project management plan development	1.3 Direction and management of project execution	1.4 Project work monitoring and control 1.5 Integrated chance control	1.6 Closing project or project phase
Project scope management		2.1 Requirement collection planning 2.2 Scope definition 2.3 WBS planning		2.4 Scope verification 2.5 Scope control	
Project cost management		3.1 Cost estimation 3.2 Budget determination		3.3 Cost control	
Project time management		4.1 Activity planning 4.2 Activity sequence planning 4.3 Activity resource estimation 4.4 Activity duration estimation 4.5 Schedule development		4.6 Schedule control	
Project quality management		5.1 Quality planning	5.2 Quality assurance	5.3 Quality control	
Project human resource management		6.1 Human resource plan development	6.2 Project team acquirement 6.3 Project team development 6.4 Project team management		
Project risk management		7.1 Risk management planning 7.2 Risk identification 7.3 Qualitative risk analysis 7.4 Quantitative risk analysis 7.5 Risk response planning		7.6 Risk monitoring and control	
Project communication management	8.1 Stakeholders identification	8.2 Communication planning	8.3 Information distribution 8.4 Stakeholder expectation management	8.5 Performance reporting	
Project procurement management		9.1 Procurement planning	9.2 Conducting procurements	9.3 Procurement administration	9.4 Procurement closure

Project human resource management includes the processes and activities that organise, manage and lead the project team (PMBOK®, 2008). The project team is composed of the people who have been assigned roles and responsibilities within the project. The team composition and number of participants may change as the resource requirement needs change throughout the project. The top managers in the base organisation are responsible for the allocation of resources to a project. Furthermore, they must see that project members are allocated time to devote to project tasks.

The personnel can be managers and employees from the organisation, but in complex projects, such as ERP system projects, the project organisation is usually complemented with consultants from the vendor.

Project risk management. Project risk is related to an uncertain event or condition that, if it occurs, affects at least one project objective, such as scope, schedule, cost or quality (PMBOK®, 2008).

Project risk management includes the processes of identifying risks related to a project and the result provided by the project. Project managers are responsible for conducting risk analyses and preventing those risks from occurring.

Project communication management includes the processes necessary to achieve timely and appropriate generation, collection, distribution, storage, retrieval and dispersion of project information (PMBOK®, 2008).

Project procurement management includes the processes necessary to purchase or acquire products, services and or results from outside the project team (PMBOK®, 2008).

3.3 Implementation strategies

Most models of ERP implementations are linear (see, e.g., Bancroft et al. 1998; Markus and Tanis 2000; Parr and Shanks 2000; Ross and Vitale 2000). However, to support complex projects, new project management approaches have been developed (see, e.g., Fernandez & Fernandez, 2008/2009; Wysocki, 2007).

In this thesis, I apply the approaches to software development provided by Wysocki (2007). These approaches are illustrated in Figure 3.2 and explained below the figure.

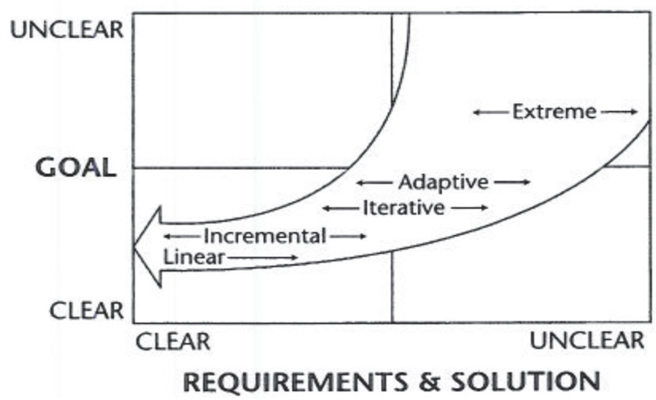


Figure 3.2 Software development life cycle approaches

The linear strategy consists of dependent, sequential phases that are executed with no feedback loops, and the project solution is not released until the final phase. Examples of such approaches are the incremental and linear implementation strategies. The incremental strategy is identical to the linear strategy except that partial solutions may be released so that business value may be delivered earlier. The iterative strategy includes feedback loops so that experiences from intermediate solutions can be used to improve the solution. Also, in the iterative strategy, partial solutions may be released. According to Wysocki (2007), the linear strategy is adequate when goals, requirements and solutions are clearly defined. An iterative strategy should be chosen when the requirements and solutions are not clear.

Projects vary in complexity and uncertainty. According to Wysocki (2007), projects can be classified along two dimensions: a clear – unclear continuum for the project goals and a clear – unclear continuum for the solution requirements.

The degree of uncertainty regarding goals and solution requirements calls for different product development approaches. Wysocki (2007) identified five approaches to product development: linear, incremental, iterative, adaptive and extreme. The main difference among the approaches is related to which project phases are reiterated, as illustrated in Figure 3.3.

According to Wysocki (2007), IS projects that reach completion go through the following five (six) phases: defining scope, designing solution, developing solution, testing solution, (customer check) and finally deployment.

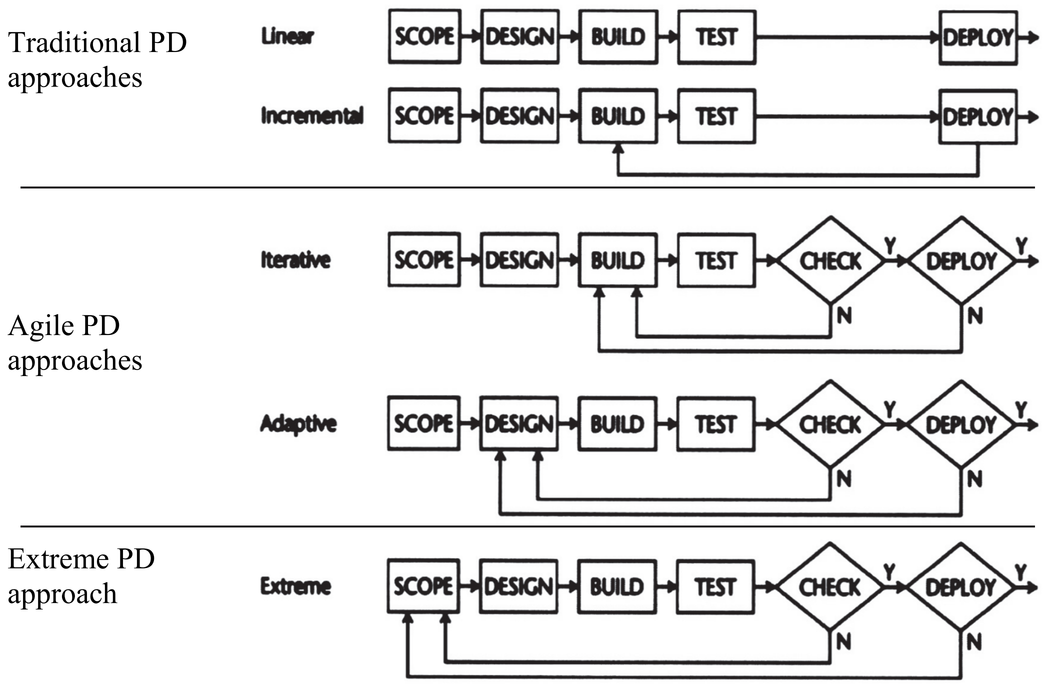


Figure 3.3 Generic software development life cycle models

3.3.1 Traditional software development approach

In traditional software product development, a linear and phased approach is applied. Linear product development consists of sequential phases. Consequently, to start the next phase or step, the previous phase or step has to be completed. In the IS literature, one series of tasks after another in linear sequence are called waterfall models (Royce, 1970).

A variant of the linear approach is the incremental approach. The incremental approach is identical to the linear approach except that partial solutions may be implemented sequentially so that uncertainty related to the solution and the project progress is reduced, because experience from the actual production setting is gained. In addition, business value may be delivered earlier in the project timeline.

The traditional approaches work well when a project is small and the project task is clear and well known. However, in large complex projects with a high degree of novelty and uncertainty, the traditional approaches are inadequate (Wysocki, 2007).

3.3.2 Agile software development approach

In traditional product development, a project is strictly planned and thereafter executed as it has been planned. However, when a project task involves the development of a system with a high degree of novelty, project members are unable to specify the final delivery in detail. Therefore, it is difficult if not impossible to carry out the development based on a completely pre-planned process.

Agile product development is a flexible approach to product development. The approach allows project members to plan and execute the project as the situation demands, in an iterative and adaptive manner.

According to Wysocki (2007), the iterative strategy includes feedback loops so that experiences from intermediate solutions can be used to discover the details of the complete solution. The adaptive strategy is similar to the iterative strategy except that the feedback from each iteration may also serve to adjust the design so that a solution will be converged upon. In both strategies partial solutions may be released.

3.3.3 Extreme software development approach

The extreme strategy is similar to the adaptive strategy except that instead of adjusting the design and solution with each iteration, the goal of the project may also be discovered and converged upon. In other words, the extreme strategy is applied when the project goal is not clear.

3.3.4 Choice of implementation strategy

Wysocki (2007) describes how project characteristics relate to the choice of appropriate strategy:

The linear strategy is adequate when the goals, solution and requirements are clearly defined and a limited number of scope change requests are expected. The incremental approach should be used when scope change requests are likely and when it is desirable to deploy business value incrementally.

The iterative strategy should be chosen when some features of the solution are not identified, when requirements are incomplete or may change, and when the remaining requirements will be clarified during the project.

The adaptive strategy is adequate when the solution and requirements are only partially known and may involve unidentified functionality, or when the development schedule is tight so that re-planning or rework is unaffordable. In such projects, multiple scope changes must be expected.

The extreme approach should be used when the goals and the solutions are unknown.

4 Research design and methods

In this chapter, I explain how I carried out the research. I start with a presentation of my conceptual model. Then, I present my research design and describe what was required to answer my research question. Next, I discuss my research setting and its suitability. I describe the data collection process and how I analysed the data. The chapter ends with a discussion of actions that I undertook to improve the validity and reliability of my study.

4.1 Conceptual model

Based on my research question and the literature review, I present my conceptual model. The model is shown in Figure 4.1.

Figure 4.1 Conceptual research model

The conceptual model shows that I assume that business managers invest in expensive ERP systems to enhance organisational effectiveness. Organisational effectiveness is an external standard of how well an organisation copes with the often conflicting and competing demands of the stakeholders on whom the organisation is dependent, such as owners, customers, suppliers and employees (for a detailed discussion, see Pfeffer & Salancik, 1978).

Top managers must be involved in ERP system implementations because an ERP system spans the whole organisation. Only the top management group has the authority to make decisions at the level above the units that will be influenced by the implementation. However, the mere *installation* of ERP system software does not create value or increase effectiveness. To increase effectiveness, the ERP system must be implemented adequately. In fact, how to influence the implementation in a way that improves organisational effectiveness remains one of the most significant challenges for managers (Uwizeyemungu & Raymond, 2009).

In the conceptual model, the ERP system implementation processes enter as a mediating variable. I assume that *how* the top managers involve themselves in the implementation processes will affect the effectiveness of the organisation in several ways. As argued by Leavitt (1965), the change variables technology, structure, people and task are interdependent. Changing the technology variable by implementing a new mandatory computerised system will inevitably cause changes in the structure, task and people variables. However, I assume that the top managers' involvement in the implementation processes may affect these changes in ways that contribute to increased organisational effectiveness.

For example, ERP systems are enablers of new work processes (Uwizeyemungu & Raymond, 2009). In my thesis, I will study how the top managers' involvement in the implementation processes contributes to changes in work processes, and how these changes may increase organisational effectiveness. However, I do not study social structures related to the people variable. Rather, I study how the deliberate design/adaptation and implementation of an ERP system enable new tasks that require the managers and employees to handle their responsibilities differently, and that may also change organisational structures and reduce the number of employees.

4.2 Research design

The purpose of this research is to enhance the understanding of how top managers' involvement in an ERP system implementation project may increase organisational effectiveness. The choice of research design must meet certain requirements to provide insights into these issues, and these requirements are discussed next.

4.2.1 Criteria for design

To answer my research question, I need to investigate top managers' involvement in an ERP system implementation process over time and as it occurs. Thus, I need a research design that meets the following requirements: 1) access to an organisation that is implementing an ERP system, 2) access to study the implementation process over time, and 3) access to the top management and other managers and employees in the organisation.

To capture the factors that influence organisational effectiveness, this research has to be done in its natural setting as the ERP system implementation process takes place. For this reason, access to an organisation that is implementing or about to implement an ERP system is fundamental.

In this thesis, I will study the implementation process by observing directly how the implementation process evolves over time. I aim to open the "black box" between inputs and outcomes. Actions and events throughout the implementation process may influence organisational effectiveness, and therefore access to the implementation process over time is necessary to take care of contextual details that may explain outcomes.

The design is meant to support the investigation of how top managers' involvement in implementation projects may have influenced work processes and therefore affected organisational effectiveness. To measure organisational effectiveness a standard of comparison is necessary. To study effects, I will develop a context-specific framework based on the managers' formulation of goals and their perceptions of factors critical to attain the goals.

ERP system software is an enabler of new processes (Uwizeyemungu & Raymond, 2009), and I will study how the top managers' involvement in an implementation project influences the exploitation of the potential of the new technology. Therefore, I must get access to managers and employees who know the work processes before and after the ERP implementation project.

4.2.2 Choice of design

To answer my research question I need to investigate an ERP system implementation process in its natural setting, which includes the complexity and the rich context accompanying real life organisations. Therefore, I have chosen a natural experiment design. "The term natural experiment describes a natural-occurring contrast between a treatment and a comparison condition" (Cook, Campbell, & Shadish, 2002, p. 17). The implementation of an ERP system represents the treatment in my natural experiment.

I decided to study one particular organisation's ERP system implementation process. Because of the complexity of an ERP system implementation project, it would not be possible for me to follow the implementation processes in more than one organisation.

The most important application of case studies, such as this natural experiment, is to explain the presumed causal links in real-life interventions that are too complex for the survey or experimental strategies (Yin, 2003). I will conduct investigations during the implementation process and investigate how the top managers' involvement may affect work processes and effectiveness in the organisation. Furthermore, I will compare and contrast business processes before and after the ERP system is put to use in the organisation. Figure 4-2 shows the research design. The period before the first dotted line indicates the situation in the organisation without the use of an ERP system, and the period after the second dotted line indicates the situation in the organisation supported by the use of an ERP system.

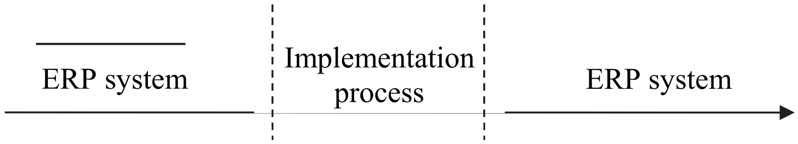


Figure 4.2 Illustration of research design

The issues most significant to investigate are the top managers' involvement in the project, the changes in relevant work processes and the effects of using the system. These issues must be investigated over time, and therefore, a longitudinal approach is necessary. Furthermore, as discussed in the literature review, implementation is here defined as an ongoing process that includes the entire process from the original idea until the ERP system is used as intended (Lucas, 1981) or abandoned.

By choosing a natural experiment and a longitudinal approach I will be able to explore how the implementation process evolves over time. I will not be able to investigate whether other factors may have influenced the effectiveness during the time of investigation. However, I assume that I will be able to identify changes in the work processes and relate possible effects of the changes to the use of the ERP system.

I will collect and analyse data during the implementation of an ERP system, and attempt to explain how the top managers' involvement in an ERP system implementation have influenced organisational effectiveness. Furthermore, I will collect and analyse data on work processes that I assume will be affected by the ERP-system implementation. I aim to compare the work processes before and after the ERP system implementation and explain how identified changes may have affected organisational effectiveness.

4.3 Research setting

I have gained access to an international window factory that fulfils the requirements discussed above. This enterprise will be referred to as Alpha. A colleague had established a relationship with Alpha in a previous project and arranged a meeting with the CEO to discuss my research proposal. We discussed needs and requirements and how to work together on the project. I was given access to study Alpha's ERP implementation project during that initial meeting.

At that time, Alpha was in the process of implementing the most essential module of their ERP system, a custom-made production planning module, which was expected to be deployed in only a few weeks. My research design required me to conduct investigations before the ERP system was deployed, and to reach that requirement I was allowed to start the research project immediately. My focus would lie on the implementation of the production-planning module, and how the production-planning process was performed before and after the deployment of the module. To assess organisational effectiveness I planned to retrieve the managers' understanding of goals and critical success factors.

In our initial meeting, the CEO explained why the implementation of the production-planning module was essential in their effort to implement a totally integrated ERP system. He emphasised that the successful outcome of the overall ERP system implementation depended on the successful implementation of this module.

After the implementation of the production-implementation module, the CEO planned a custom-made sales module. The sales module was also essential because the sellers would enter the sales data into the ERP system using this module. If possible, I would include the sales module in my study.

The implementation project in Alpha satisfied my design criteria. Furthermore, the CEO's decision that the production-planning and the sales modules needed to be custom-made in order to take care of competitive advantages added an innovative aspect to the project. At the time, managers were advised to implement the vanilla version of an ERP system package.

The ERP system implementation project in Alpha started in 1999 with the implementation of three standard ERP system modules. These modules were implemented/deployed and used within one year. The initial years of the ERP implementation, from 1999 until 2006, I have studied in retrospect. The emphasis of my study is on the implementation of the fourth ERP system module, the production-planning module, and the fifth module, the sales module. The ERP system modules are units of analyses in my study, and they are lined up in Table 4.1.

Table 4.1 Modules studied

	Module 1	**Module 2**	**Module 3**	**Module 4**	**Module 5**
Module	Accounting module	Procurement module	Warehousing module	Production planning module	Sales module
Process involved	The accounting, process	The purchase process	The warehousing process	The production planning process	The sales planning process
Year of deployment	1999/2000	1999/2000	1999/2000	Planned deployment medio 2006	Planned implementation after PM

The Alpha enterprise and the ERP system implementation project are further described in Chapter 5.

4.4 Data collection

A case study needs multiple sources of data and typically combines data collecting methods (Eisenhardt, 1989). In this thesis, the case study is conducted as a natural experiment, and to enhance validity, data triangulation is applied. I have interviewed top managers, other managers and employees, observed work processes and studied documentary data to increase validity of my study. The aim is to collect qualitative and quantitative data that may illuminate my research question from various perspectives.

4.4.1 Interviews

To elicit organisational goals and the factors that are critical to achieve these goals, I have interviewed top managers. To retrieve data regarding organisational work processes and the implementation process, I interviewed several other managers and employees. The interviews were semi-structured, and I used a prepared interview guide (see Appendix I), covering main questions and topics to be addressed. Occasionally, some questions or topics were adapted for the role of the respondent. For example, when interviewing managers at the corporate level we discussed how strategies were prepared and should be implemented. When interviewing other managers and employees we discussed how strategies actually were implemented. Figure 4.3 illustrates the data collection process.

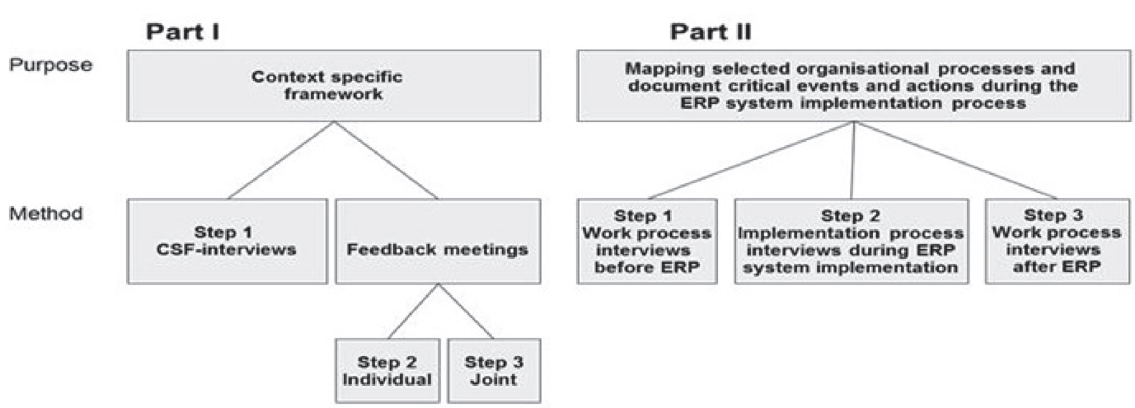


Figure 4.3 Key data collection steps

Part I: Data were collected in two main stages, and in the first part most of the interviews were conducted in collaboration with one or two colleagues. In Part I, we interviewed the managers to collect data on their goals and the factors the managers considered critical to attain those goals (Fuglseth, 1989; Rockart, 1979). The purpose was to establish a context-specific goal and critical success factor (CSF) hierarchy that served as a standard of comparison in the evaluation of goal attainment and effectiveness. I chose the CSF approach because I assumed that the managers in Alpha knew best what their goals were and how to achieve them. Also, this approach yielded rich data that helped me identify the factors that the managers saw as critical for achieving their goals.

The CSF method developed by Rockart (1979) and extended by Fuglseth (1989) is an open-ended interview method designed to elicit data about organisational goals and factors that the managers consider critical for attaining these goals (Fuglseth, 1989).

In cooperation with a colleague, I gathered goal and CSF data at three different occasions/steps as indicated in the figure.

In step 1, we interviewed the managers individually. The interviews were conducted in March 2006. We interviewed five managers, of whom four were top managers and one was the former project manager. First, we opened the interviews with a clarification of the purpose and agenda for the interview. The first topic we discussed was the managers' tasks and role in the organisation. Thereafter, we asked the managers to describe the Alpha enterprise, the industry, Alpha's position in the industry and its corporate strategy. The emphasis of the interviews was then put on elicitation of goals and CSFs. The goals were noted on Post-It Notes, which we then organised t into hierarchies of primary and secondary goals. Based on the goals that came to light during the interviews, the managers' perception of critical success factors were discussed. We elicited the CSFs by asking which factors were critical in achieving each goal.

The interviews were tape-recorded and transcribed before being analysed. We analysed the interviews by aggregating and grouping the goals and CSFs retrieved from each manager. The data were registered in an Excel worksheet with one column for each manager and another column for their aggregated results. We compared the results from each manager and discussed how to group the goals and CSFs in a way that expressed the managers' intended meaning. In the column for aggregated results we counted how many of the managers had mentioned each goal or CSF.

In step 2, we met with the managers individually for a second time. These individual feedback meetings took place two months after the first interviews. In the meetings we examined the results from the first round of interviews, and the managers were given the opportunity to add, revise or remove statements. We presented our preliminary analysis results, and the managers would agree or disagree with our analysis. In addition, the individual feedback meetings provided an opportunity for us to clarify aspects that were unclear after the first interviews. For example, in the interviews conducted in step 1, several managers mentioned similar factors but used different wording, which provided a ground for misinterpretation. Therefore, to aggregate the responses from different managers we needed to clarify the intended meaning of a previously mentioned factor. To do so we asked the managers whether they considered certain factors identical to factors mentioned by another manager. They would then elaborate on the factors and clarify whether they perceived them to be the same or different. Based on the feedback from the managers, the analyses of goals and CSFs were adjusted.

Step 3 consisted of a joint feedback meeting with the whole management group. This meeting was conducted in June 2006, about a month after the individual feedback meeting session. After conducting the interviews and feedback meetings in step 1 and 2 the analysis work was continued. We aggregated and grouped concepts. Based on our interpretation of the collected data, we prepared a framework consisting of goals and CSFs. This framework was presented to the managers as a basis for further discussion and feedback. In the joint feedback meeting, the managers had the opportunity to collectively correct misunderstandings and to add, revise or remove concepts. No changes were suggested, and the managers stated that the framework represented an accurate overview of how they perceived their goals and how to achieve them. The feedback meetings thus validated the results of our research.

Part II: The second part of my data collection served two purposes: 1) Work process data were collected to model selected organisational processes before and after the deployment of ERP system modules. 2) Implementation process interviews were conducted to document the developing process of the ERP system implementation project.

To collect work-process data, I interviewed managers and employees in Alpha both before and after the deployment and use of the ERP system modules. The 'before' and 'after' descriptions were essential for comparing processes. In my contacts with the top managers, I emphasised the need to get access to managers and employees who had both knowledge about and experience with the work process. Key informants, experts in their areas, were then chosen as respondents in the effort to model the work processes.

I had prepared a comprehensive interview guide for collecting data on the work processes. It turned out, however, that I learned more about the work processes when I let the informants talk and just structured the interview around the phases of a general problem-solving process (e.g., Mayer, 1992), that is, problem definition, problem solving and evaluation. I asked questions such as: How do you know what to do in your job? Can you show me how you perform the task step by step? How do you know when you have handled the task satisfactorily? Could you have handled the task in another way? The discussions were concentrated around roles, activities and systems involved in the work processes. During the interviews, some informants illustrated how the work process was performed. For example, they demonstrated how to use their current ICT systems. During these demonstrations, I asked for and received relevant documents and screenshots. All key informants offered or agreed to be contacted later if I needed to clarify any answers.

My interviews were conducted alongside the daily operations in Alpha, and to occupy more than one or two employees of a work group for a lengthy period would hamper the work process. However, to verify the responses, the informants would ask for assistance from a colleague to help clarify answers.

After the interviews, I modelled the process according to a process-modelling technique that I extended based on the RIC modelling technique (Roles In Cooperation, Iden 2009). In the consultant literature, a great number of books have been written about business process modelling techniques. However, the purpose of the techniques in the consultant literature is often to improve business processes. The role of a researcher is usually very different from the consultant's role. From a researcher perspective, the purposes of modelling business processes and modelling technique requirements may vary. In this study, the purpose of process modelling was to describe and analyse if and how changes in work processes may have affected organisational effectiveness. Therefore, I have extended the RIC technique for my purposes based on the requirements of this study. This methodology is described at length in Appendix III and applied in Chapter 7.

I modelled the work processes right after the interviews were conducted. If and when I was confronted with a problem or just needed to clarify a question, I consulted the key informants. The process models were then sent to the key informants for validation. Usually a telephone meeting was arranged to validate the accuracy of the work process models. In these meetings, I explained the method I had used and the symbols involved to illustrate the work process (as-is). Thereafter, I went through the work process step by step with the respondent to discover faults and weaknesses. The work-process models were revised and adjusted in accordance with these discussions.

Depending on the extent of the changes, the models were either completed after the first round of verification or, if necessary, after a second round of verification. Typically, I would enclose the work process models in an e-mail to the respondents to complete the verification process. It can be useful to present and assess the accuracy of the work process models in a broader workgroup (Feldman, 1976). Therefore, when a key respondent offered to involve co-workers in the verification of the sales process, this effort was highly appreciated as this increased the validity of my study.

The process models provided visual representation of the work processes in Alpha before and after the deployment of an ERP system module. With these models, I was able to identify and analyse changes that might have occurred as a result of implementing the ERP system modules. In my analyses, I have explained how identified changes could be attributed to the ERP system implementation.

To obtain data regarding the ERP system implementation process I interviewed a selection of top managers and other employees involved in the ERP project throughout the implementation period. A total of five interviews were conducted primarily to document the implementation process. These interviews were usually conducted on the Alpha premises. In some cases, they were arranged in Bergen at NHH or as phone meetings. I prepared a schedule that covered the main topics to be discussed during these interviews. As part of the preparation work before each interview/conversation, I revisited the previous interview so that I could start with a short summary and follow up on the progress since our last conversation. During the meetings/interviews, critical events were discussed to obtain data regarding events and actions that constituted the implementation project. When an event critical to the progress of the implementation process was detected, I asked more questions to learn as much as possible about the event and the process by which it occurred. During the interviews, I was particularly attentive to keywords, such as problem, challenge, surprise, delay, difficult etc. In addition, I asked the respondents to clarify meaning when they used unexpected terminology to describe a situation such as "warts on the system", "castle in the air" and "stowaways in the production". This data collection resulted in a rich description of the ERP system implementation process.

The most important data came from the interviews with managers and other employees of Alpha. Table 4.2 below shows an overview of the 55 interviews conducted. The table is organised as follows. Interview number is shown in column one, the date in column two, the type of interview in column three, the respondent role and number in columns four and five, respectively. Some of the respondents were promoted during this study. The table shows the role that the respondents held at the time of the interview. Finally, the respondent's affiliation is shown in column six and the location of the interview in column seven.

Table 4.2 Overview of the interviews

No.	Date of interview	Type of interview	Role of respondent	Resp. no.	Location affiliation	Location for interview
HQ-respondents:						
1	17.03.2006	Goal- and CSF 1	Top Manager	1	Headquarter	Headquarter
2	17.03.2006	Goal- and CSF 1	Top Manager	2	Headquarter	Headquarter
3	15.03.2006	Goal- and CSF 1	Top Manager	3	Headquarter	Headquarter
4	16.03.2006	Goal- and CSF 1	Top Manager	4	Headquarter	Headquarter
5	15.03.2006	Goal- and CSF 1	Manager	5	Headquarter	Headquarter
6	16.03.2006	Meeting 1	Manager	6	Headquarter	Headquarter
7	23.05.2006	Goal- and CSF 2	Top Manager	1	Headquarter	Headquarter
8	22.05.2006	Goal- and CSF 2	Top Manager	2	Headquarter	Headquarter
9	22.05.2006	Goal- and CSF 2	Top Manager	3	Headquarter	Headquarter
10	23.05.2006	Goal- and CSF 2	Top Manager	4	Headquarter	Headquarter
11	23.05.2006	Goal- and CSF 2	Manager	5	Headquarter	Headquarter
12	22.05.2006	Meeting 2	Manager	6	Headquarter	Headquarter
13	19.06.2006	Joint feedback	Top Manager	1	Headquarter	Headquarter
14	19.06.2006	Joint feedback	Top Manager	2	Headquarter	Headquarter
15	19.06.2006	Joint feedback	Top Manager	3	Headquarter	Headquarter
16	19.06.2006	Joint feedback	Top Manager	4	Headquarter	Headquarter
17	19.06.2006	Joint feedback	Manager	5	Headquarter	Headquarter
18	19.06.2006	Joint feedback	Manager	6	Headquarter	Headquarter
19	13.03.2007	Process int. & obs.	Manager	5	Headquarter	Headquarter
20	13.03.2007	Process int. & obs.	Manager (sale)	10	Headquarter	Headquarter
21	13.03.2007	Process int. & obs.	Manager (sale)	11	Headquarter	Headquarter
22	13.03.2007	Process int. & obs.	Manager (sale)	12	Headquarter	Headquarter
23	13.03.2007	Process int. & obs.	Transport	16	Headquarter	Headquarter
24	14.03.2007	Process int. & obs.	Manager (sale)	13	Headquarter	Headquarter
25	14.03.2007	Process int. & obs.	Manager purchase	14	Headquarter	Headquarter
26	14.03.2007	Process int. & obs.	Purchaser	15	Headquarter	Headquarter
27	14.03.2008	Implementation int.	Project Manager	7	HQ IT-dep.	IT-dep.
28	14.03.2008	Implementation int.	Senior IT	8	HQ IT-dep.	IT-dep. Phone
29	14.03.2008	Process int. & obs.	Manager (sale)	10	Headquarter	Headquarter
30	14.03.2008	Process int. & obs.	Manager (sale)	13	Headquarter	Headquarter
31	15.04.2008	Process interview	Manager (sale)	11	Headquarter	Phone
32	22.01.2009	Implementation int.	Senior IT	8	HQ IT-dep.	IT-dep. Phone
33	04.09.2009	Implementation int.	Senior IT	9	HQ IT-dep.	Bergen
34	04.09.2009	Implementation int.	Senior IT	9	HQ IT-dep.	Bergen
35	10.11.2010	Process int. & obs.	Senior IT	8	HQ IT-dep.	Phone/Mikogo
36	30.05.2013	Implementation int.	Top Manager	1	Headquarter	Headquarter
37	30.05.2013	Implementation int.	Top Manager	2	Headquarter	Headquarter
38	30.05.2013	Implementation int.	Top Manager	5	Headquarter	Headquarter

Pilot factory respondents:						
39	*23.03.2007*	*Process int. & obs.*	*Prod. planner*	*19*	*Pilot factory*	*Pilot factory*
40	23.03.2007	Process int. & obs.	Prod. admin.	20	Pilot factory	Pilot factory
41	23.03.2007	Process int. & obs.	Prod. admin.	21	Pilot factory	Pilot factory
42	23.03.2007	Process int. & obs.	Foreman (prod.)	22	Pilot factory	Pilot factory
43	23.03.2007	Process int. & obs.	Foreman (prod.)	23	Pilot factory	Pilot factory
44	23.03.2007	Process int. & obs.	Foreman (prod.)	24	Pilot factory	Pilot factory
45	23.03.2007	Process int. & obs.	Foreman (trans.)	25	Pilot factory	Pilot factory
46	23.03.2007	Process int. & obs.	Purchaser	26	Pilot factory	Pilot factory
47	23.03.2007	Process int. & obs.	Warehouse	27	Pilot factory	Pilot factory
Sales unit respondents:						
48	14.03.2007	Process int. & obs.	Senior seller	17	Sales office	Sales office
49	14.03.2007	Process int. & obs.	Senior seller	18	Sales office	Sales office
50	13.03.2008	Process int. & obs.	Senior seller	17	Sales office	Sales office
51	13.03.2008	Process int. & obs.	Senior seller	18	Sales office	Sales office
52	02.03.2009	Process interview	Senior seller	17	Sales office	Phone
53	16.04.2009	Process interview	Senior seller	17	Sales office	Phone
54	17.04.2009	Process interview	Senior seller	18	Sales office	Phone
55	31.05.2013	Process interview	Sales manager	17	Sales office	Sales office

In this table: Dep. = department, prod. = production, admin. = administration, trans. = transport

The work process data were collected in proximity to the deployment of the sale and production-planning modules. Most of the interviews and observations conducted through these periods thus represent real time data. Some informants representing different departments became key respondents and were interviewed several times. The key informants were often contacted when I needed clarifications or a quick answer to a question. Since these conversations were informal and unstructured they are not listed in the table. However, they are worth mentioning since the access to quick answers simplified the data collection process.

4.4.2 Observations and documents

During the work-process interviews, I asked the respondents to show me how their processes worked. The respondents then demonstrated, step by step, how to perform particular tasks. I have followed demonstrations of the following work processes: 1) the sales process, 2) the production-planning process and 3) the production process. The two former processes were for the most part supported by a computerised system. The latter, the production process, was not. The observations are described in the following.

For about four months, Alpha used two sales systems: the legacy system and the new system were in production at the same time. I interviewed a senior seller during that time, and he demonstrated how the legacy system and the new system were used. After these demonstrations, I asked for documentation that could illustrate the functionality. Shortly after, the senior seller provided an example of a sales order and screen shots from the new system and e-mailed them to me. These examples documented parts of the demonstration that I had observed.

I have also observed how the new production-planning module supported the production-planning process. These observations were conducted simultaneously with work process interviews. One of the interviews was conducted as a phone meeting, and in this interview demonstrations were enabled by Mikogo software (https://www.mikogo.com). Mikogo is a web-conferencing solution that provides desktop sharing, and with this software application the respondent was able to demonstrate system functionality. In the same way as the sales module, screen shots documented parts of the observation process. The most relevant screenshots are included in the analyses of this study.

When I interviewed production workers in one of the factories, the respondents demonstrated how they performed their daily work routines, for example, how they planed the timber or assembled the windows. Thus, I was able to observe parts of the production-planning process as well as the production process. For the latter, I would document my observations by taking photographs.

In addition, I collected relevant documents such as reports, goal and strategy documents, flow charts, etc. Most of the documentation was retrieved in connection with the interviews. When answering questions, respondents sometimes referred to documents. If relevant, I followed up by asking for a copy, which was how documents were added to my collection of data.

During CSF interviews with the top managers in Alpha, we discussed topics, such as goals. This topic had been discussed and carefully documented in the management group. Typically, when the managers were asked to account for their goals they would refer to documents describing their goals in detail. In particular, the CEO provided documentation of Alpha's goals and strategies. Table 4.3 outlines the various documents and other documentation retrieved in the data collection period.

Table 4.3 Documentation and other documentation retrieved in the data collection process

Date collected	Title or description of document	Provided by
Documentation pertaining to goals and strategies:		
	Our business idea	CEO
	Principal objective	CEO
	What we want to achieve	CEO
	Superordinate goals 2006 – 2008: Annual turnover on factory level	CEO
	Superordinate goals 2006 – 2008: Annual turnover on market level	CEO
	Framework condition for the project	CEO
	Reasons for implementing a totally integrated IT system	CEO
	Financial management model - objectives	Finance manager
	Presentation of project goals for the management group	Project manager
Documentation pertaining to work processes:		
	Production planning process:	
111110	Selected screen shots from the PM2 module with comments	Senior IT
	Example of a monthly financial report from a production unit	Finance manager
250407	Report: production from pilot factory week 15/07	Pilot factory manager
250407	Factory status from Alpha week 15/07	Pilot factory manager
200407	Pictures taken to illustrate the various steps in the production process	HB
	Sales process:	
	Selected screen shots from the sales module	Senior seller
310513	Screenshot sales system: Example of system warning	Senior seller
310513	Screenshot sales system: Example of "offer stop"	Senior seller
310513	Screenshot sales system: Example of detailed registration	Senior seller
310513	Print out: Example of an offer from the legacy system	Senior seller
310513	Print out: Example of an offer from SM	Senior seller
	Sales material	Senior seller
	The window and door book	Both senior sellers
Documentation pertaining to ERP system implementation processes:		
270406	Presentation for factory managers: the ERP solution	Project manager
	Basic course: ERP in Alpha	Project manager
	Basic course: ERP in Alpha	Senior IT
140408	Pre-project report: Implementing production planning (Alpha/consultants)	Senior IT
140408	Work report: Alpha ERP system	Senior IT
140408	Pre-project report (internal): Recommendations for the steering committee	Senior IT
140408	Presentation: Pre-project PM2	Senior IT
140408	Presentation: Report (internal)	Senior IT
	Financial management model - reporting system	Finance manager
	Financial management model - budget and estimates	Finance manager
	Financial management model - profit centres	Finance manager
	Financial management model - invoicing principle model	Finance manager
	Financial management model - calculation model	Finance manager
	Financial management model - profit centres	Finance manager
	Item data description in ERP system	Finance manager
	Order structure in ERP system	Finance manager
	ERP system overview – broad and seamlessly integrated	Technical PM
17.08.09	Example of function test	Technical PM manager

Remaining documents:		
	Proposal: new operational model	CEO
	Annual report 2002	Project manager
	Annual report 2003	Project manager
	Annual report 2004	Project manager
	Annual report 2005	Project manager
250407	Progress aluminium project	Pilot factory manager
250407	Layout aluminium project	Pilot factory manager

To summarise, I have applied interviews, observation and documents to collect data for this thesis. Data pertaining to the modules implemented before 2006, I have collected in retrospect. Table 4.4 provides an overview over data collection methods applied for the various units of analysis.

Table 4.4 Data collection methods for each module

	Module 1	**Module 2**	**Module 3**	**Module 4**	**Module 5**
Module	Accounting module	Purchasing module	Warehousing module	Production planning module	Sales module
Data collection methods	Interviews, documentation	Interviews, documentation	Interviews, documentation	Interviews, observation, documentation	Interviews, observation, documentation

4.5 Data analysis

In this section, I explain how I have analysed my data. According to Pettigrew (1990) the process of analysing data does not proceed in a linear way. To make sense of the multitude of data collected over the several years of this study, I have applied an iterative process altering between using the data and the literature review and the conceptual frameworks to apply meaning to the data.

My effort to assess whether the implementation of an ERP system in Alpha has influenced effectiveness can be divided into three main study areas. First, I have categorised goals and CSFs. Second, I have modelled work processes before and after the deployment of ERP system modules, and third, I have mapped critical events and actions during the ERP system implementation project. The analyses of these three areas are described next.

4.5.1 Analysis of goals and CSFs

I have accounted for the analysis of goals and CSFs in section 4.4.1. The data collection process and the analysis of the data were intertwined. The data collection regarding goals and CSFs was conducted in three steps as illustrated in Figure 4.4 (step I). The data were analysed between each data collection step as described in Section 4.4.1. The CSFs were divided into internal and external factors. Furthermore, the internal CSFs were categorised into strategical, tactical and operational CSFs. However, the operational CSFs were not included in the final CSF framework presented in Chapter 5.

4.5.2 Work process analysis

The focus of my work process analysis was on the sales and production-planning process. I have analysed work processes by modelling each process before and after the deployment and use of an ERP system module. I identified work process changes based on a comparison of the "before" and "after" process models. The changes were then assessed to decide if and how they may have influenced critical success factors and subsequently organisational effectiveness.

4.5.3 Analysis of the ERP system implementation

The implementation of the first three standard ERP system modules was studied in retrospect. The implementation of the production-planning module started in 2003, and therefore this module was studied both in retrospect and in real time. The implementation of the sales module was studied entirely in real time.

Lyytinen and Newman (2006, 2008) developed a model, termed Punctuated Socio-technical Information system Change) (PSIC), to describe and explain processes related to the implementation of information systems. I have applied an extended version of the PSIC model to guide the description and analysis of my ERP system implementation data. My extensions are explained in detail in Appendix II.

I have mapped critical events and actions, including the interactions among levels, by applying the extended PSIC model, as described in Appendix II. Based on Leavitt's (1965) socio-technical (S-T) theory, misalignments among the four variables task, structure, actor and technology were identified, mapped and described. In addition, preliminary outcomes related to the various units of analysis were presented in the model. Thus, the model provided a graphical overview over the longitudinal development of the project.

To analyse the implementation project, I compared the various modules with one another. In this analysis the categories I used for comparison were partly based on Wysocki's (2007) project characteristics and project management strategies as described in Chapter 3. Furthermore, I compared the modules and based on the different characteristics, I discussed possible reasons for a successful or unsuccessful outcome.

4.6 Validity and reliability

In this Section, I discuss the initiatives I have taken to increase the validity and reliability of this study.

4.6.1 Descriptive validity

Johnson (1997, pp. 284, 285) describes descriptive validity, as "… the factual accuracy of the account as reported by the researchers …. In other words, descriptive validity refers to accuracy in reporting descriptive information (e.g., description of events, objects, behaviours, people, settings, times, and places)". To improve descriptive validity in this study, I used investigator triangulation, and I recorded and transcribed my interviews.

According to Johnson (1997), one effective strategy used to obtain descriptive validity is investigator triangulation, that is, the use of multiple investigators. In this study, the CSF interviews were conducted with two researchers present. After each interview, facts were cross-checked with the other researcher. We compared notes and agreed upon what took place during the interviews and observations. Hence, the factual accuracy of the data in this study was increased because I discussed the data collected from the interviews and the observations with my colleague.

Furthermore, to ensure the detailed and accurate wordings of the respondents I recorded the interviews. The recorded interviews were later transcribed and used as the foundation for the data analysis. This initiative contributed to the factual accuracy of the statements made by the respondents. It would have been impossible to write down all the details of the responses and discussions during the interviews. Therefore, without the recordings, I would have lost details from the interviews, and the factual accuracy would probably have decreased. Furthermore, the recordings made it possible to revisit the actual statements from the context they were elicited.

In summary, these initiatives contributed to strengthening the descriptive validity of my results by ensuring the accuracy of the description of the data collected.

4.6.2 Interpretive validity

According to Johnsen (1997, p. 285), "Interpretive validity refers to accurately portraying the meaning attached by participants to what is being studied by the researcher." More specifically, it concerns the degree to which the research participants' viewpoints, thoughts, intentions and experiences are accurately understood by the researcher and portrayed in the research report (Johnson, 1997). To increase the interpretive validity of my data analysis, I took two initiatives:

I used participant feedback (Johnson, 1997) during my data collection. The data analysis was checked and verified by my respondents. During the participants' feedback, they had the opportunity to agree or disagree with the analysis, thereby clarifying areas of miscommunication.

During the CSF feedback meetings, I asked my respondents about the meaning of factors they had mentioned, which helped me interpret the data. In addition, I used this opportunity to get feedback on the interpreted relationships among the goals and factors, which ensured that I had interpreted the responses of my respondents correctly. The respondents were also given the opportunity to delete and add statements if they felt that I had misinterpreted them. These actions helped to clarify that information used in my analysis was interpreted as accurately as possible. In general, very few changes were necessary after the feedback meetings.

During the business-process modelling, I obtained feedback from the respondents several times. First, I made a draft based on the first interviews, thereafter I presented the process model draft for the respondents. Based on their feedback, I revised the models. This process (receive feedback – revise models – present models – receive feedback) was repeated until the models represented the business process accurately, according to my respondents.

Furthermore, to support the interpretations of the statements provided by the respondents during the interviews, I used direct quotes from the transcriptions as recommended by Johnson (1997). The direct quotes included in this thesis provide the reader with the opportunity to read the respondents' words verbatim, and thus the readers may experience for themselves the respondents' perspective, which improves the interpretive validity of the data analysis in this study.

4.6.3 Internal validity

Internal validity refers to the causal relationship among variables and results (see, e.g., Cook & Campbell, 1979; Gibbert, Ruigrok, & Wicki, 2008; Johnson, 1997). According to Johnson (1997), the strategies discussed above, used to improve descriptive and interpretive validity, are as well used to improve the internal validity of qualitative research. In addition, *methods triangulation* and *data triangulation* are among the initiatives that have been suggested to increase internal validity, and the two latter strategies are discussed below.

Johnson (1997) argued that *methods triangulation* includes several methods of research as well as different types of data collection procedures in a single research study. In this study, I have used different data collection procedures, such as interviews, observations and documents. The data collection procedures supported and strengthened one another, for example, findings from interviews were supported by documentary evidence, and furthermore strengthened by observations (e.g. of work processes). Thus, the patterns and tentative causal relationships I identified were corroborated and strengthened through various data collection procedures.

Data triangulation refers to the use of multiple data sources using a single method (Johnson, 1997). As explained in the data collection section of this chapter, I used multiple data sources (i.e. respondents) to help me understand the implementation project and the work processes before and after the ERP system implementation project. I conducted interviews with several managers and other employees and observed several employees at work. These interviews and observations were intertwined, and as explained in the data collection section of this chapter, they were conducted at various times during the implementation process.

Thus, in addition to the initiatives I have taken to increase the descriptive and interpretive validity, use of different methods of data collection (methods triangulation) and multiple data sources (data triangulation) improved the internal validity of my study.

4.6.4 External validity

One challenge in using the case study approach is external validity or generalisability (Eisenhardt, 1989). Generalisability is not the purpose of my study, however according to Johnson (1997, p. 290), it is reasonable to generalise to other people, settings and times to the degree that they are similar to the people, settings, and times in the original study. Therefore, the initiatives proposed by Johnson (1997) are followed in this study to help readers understand when results can be generalised. In this thesis, this chapter, the first part of Chapter 5 and Chapter 7, Appendix II and III include descriptions of the following: 1) number and roles of interviewees in the study, 2) selection of participants for inclusion in the study, 3) contextual information about Alpha 4) methods used for data collection and 5) data analysis techniques. By documenting these aspects, the readers have the information needed to replicate this study or make decisions about the degree to which the results can be generalised.

4.6.5 Reliability

Reliability concerns reducing the errors and biases in the study. Denzin and Lincoln (1994) suggested that reliability is about enabling subsequent researchers to arrive at the same insights if they conduct the same study along the same steps again.

In this chapter, I have described in detail how I conducted this study. My aim was to provide transparency through careful documentation and clarification of the research procedures, which are among the main means of achieving reliability (Gibbert et al., 2008).

5 Analysis of the CSF interviews

In this chapter, I present my analysis of the CSF data. In Chapter 2, the term Critical Success Factor (CSF) was used when I reviewed the literature attempting to identify and define *generic* factors critical to the implementation of information systems, including enterprise systems. In this chapter, the term CSF is used as the term was originally presented by Rockart (1979, p. 85) as individual managers' perceptions of the factors that are critical to attain organisational goals.

I interviewed five managers in Alpha, the top manager and the managers for sale, production, procurement and planning. The purpose of the analysis is to develop a context-specific framework for evaluating the effects of the ERP system on organisational effectiveness. The goals represent the managers' perspectives on organisational effectiveness. The CSFs are the managers' perceptions of factors critical to attaining the organisational goals. The CSFs include factors that managers must take into account to satisfy other stakeholders, such as customers, suppliers, employees and authorities. This framework constitutes the operationalisation of organisational effectiveness in Alpha and in this study. The framework will be applied in Chapter 7 when I analyse whether and, if so, how the implementation of an ERP system influenced organisational effectiveness in Alpha.

In the first part of this chapter, I will present the Alpha enterprise in more detail, emphasising how the managers planned the implementation of the ERP system. The presentation is based on several meetings with the managers during data collection, but particularly on the managers' answers to the first questions of the CSF interview when they talked about their jobs. The analysis of the goals and factors was shown to the interviewed managers and discussed with them to improve validity, as explained in Chapter 4. During the feedback meetings, the managers clarified the meaning of some goals and factors, and they resolved misunderstandings.

5.1 The Alpha enterprise

The Alpha enterprise is one of the leading producers of windows in Scandinavia, with over 1500 employees and a turnover of about 200 million Euros. The enterprise operates internationally, with subsidiaries, sales offices and production facilities in several European countries.

The enterprise has a good financial standing, and the top manager and the management group are keen to manage the assets well but also to create good conditions for the employees and the local community. Most of the employees at the Norwegian headquarters and main factory are recruited locally and educated internally, and they tend to stay in the organisation for many years.

Alpha maintains a close contact with scientific establishments to meet society's and regulatory government's constantly developing demands. The managers want to stay ahead of energy-saving technical developments. The managers and employees are dedicated and have a strong focus on offering the best possible products and supporting the customers in finding products that meet their needs.

Alpha offers windows by measure – that is, with variable breadth and height, termed VBH products. The customers define the size of the products they want to order. Changing the size of either the breadth or height of a product by one millimetre makes a different product. Therefore, there are a vast number of possible product varieties in window production. One might say that VBH window production has certain similarities with float production.

At the end of the twentieth century, Alpha had several standalone information systems, and the managers saw a potential to improve organisational effectiveness by implementing an ERP system. In addition, the managers feared that some of the legacy systems would not survive the turn of the century.

The Y2K problem implied that the implementation of an ERP system in Alpha was initiated in 1999. At that time, most ERP system packages were developed for the production of discrete predefined parts, and they were not well suited to support process industries. Thus, the managers realised that no commercially available package was suitable for their production planning process. They understood that customisation would be both difficult and risky, but still the best possible solution for business-critical processes, such as the sales process and the production-planning process.

The ERP project started with a comprehensive planning period. Data from the CSF interviews show that the top manager together with some of his employees developed a clear vision of how the enterprise should look after the implementation of the ERP system. The vision was dominated by considerations to improve organisational effectiveness enabled by the developments within integrated information systems, particularly, production planning and improving the utilisation of capacities in the various production units.

An important part of the project-planning phase was the preparation of the invitation to tender. Because the managers were aware of the problems finding a suitable package in 1999, the invitation to tender included a "case" explaining the VBH window production. The top manager demanded that interested vendors should explain how they would handle the problem of representing VBH planning and production in the ERP system. After a thorough selection process, a vendor was chosen. In the contract, the vendor agreed to develop a custom-made production-planning module at a fixed price.

During the tender process, the top manager made internal preparations to facilitate the implementation process. He established a project group with the task to standardise the names of the many components that were used in the production processes in the factories in Norway and abroad.

When a vendor had been selected and a contract signed, a project organisation with members from the ERP vendor and Alpha was established. The project was organised with a project manager, a project group and a steering committee. The members of the steering committee were the top manager and the technical manager, the latter of whom was the manager in charge of the window production and window innovation efforts. The internal core members of the project group were three employees from the IT department with a thorough knowledge of Alpha's business and administration processes. Additional members were appointed based on their competence when needed. The project members were explicitly allocated time to devote to the project work.

Together with the vendor, the members of the steering committee developed a plan for the implementation of the ERP system. The members were aware that the design of the production-planning module would be a challenge, and they decided to postpone handling the challenge until they had solved the Y2K problem. In other words, they decided to replace legacy systems with new ERP modules for accounting, procurement and warehouse management. The project was thus divided into three sub-projects:

1) vanilla implementation of the accounting, the procurement and the warehouse management modules
2) design, development and deployment of the production-planning module
3) design, development and deployment of a custom-made sales module

An additional reason for dividing the ERP implementation process into sub-projects was that Alpha had few employees with the competence to ensure that the context-specific adaptations/developments of the modules genuinely represented the procedures.

When I started to collect data in Alpha, the three modules from the selected ERP package had been implemented (sub-project 1). The three modules supported accounting, procurement and warehousing processes. These modules were deployed within a year and were studied in retrospect.

5.2 Analysis of goals and policies

Table 5.1 gives an overview of the elicited organisational goals and policies. The goals are the final results towards which the managers' efforts are directed. Policies are restrictions that the owners impose on the managers and expect them to follow, such as health, safety and environment regulations (Anthony & Dearden, 1976). In this case, the owners are also top managers in the enterprise. Therefore, the policies are restrictions that these managers have decided to impose on themselves and their employees.

In Table 5.1, I have focused on the long-term primary goals of the enterprise. The primary goals are translated into operational goals for each factory, such as specific production goals. These secondary goals are not included in Table 5.1 because I focus on effects of the ERP system at the enterprise level.

The table is organised as follows: The first row shows the label of each manager. The left side of the table illustrates which goals were mentioned and how I have categorised these goals. The right side of the table indicates which manager(s) mentioned the different goals during the CSF interviews.

On the left side of the table, I have organised the managers' goals into three main categories: profitability, growth and survival. Rows marked with bold text represent main categories. I grouped the policy statements as a separate category. In the table, G means goal, and P means policy. The sub-categories are presented below the main category in bold text and indented. The lowest level represents the specific goals/policies mentioned by the managers. As for the operational goals, the values are replaced by symbols in order not to reveal the actual numbers.

To the right of the total column, each manager interviewed has his own column numbered from M1 to M5, as indicated in the top row, in which M indicates manager. If a manager mentioned a goal/policy, it is indicated with the number "1" in the manager's column. A "1" indicates that the manager mentioned at least one goal/policy belonging to the category/sub-category. How often a goal/policy was mentioned by a manager is shown in the total column.

Table 5.1 Goals mentioned by managers in Alpha

Goals:		Sum	M1	M2	M3	M4	M5
G1	**Profitability:**	**5**	**1**	**1**	**1**	**1**	**1**
	Attain operating profit of min. x%	**4**	1	1	1		1
G1.1	**Increase income**	**4**	**1**	**1**	**1**	**1**	
	Attain sales of NOK y billion next year	**3**	1	1	1		
	Increase sales by z_1 - z_2% during the next three years	**3**	1	1	1		
	Increase sales in Ireland and UK	**1**		1			
G1.2	**Reduce costs**	**5**	**1**	**1**	**1**	**1**	**1**
	Reduce product costs	**3**	1	1			1
	Reduce costs continuously	**1**					1
	Reduce cost-base by u% each year	**2**	1		1		
G2	**Growth:**	**3**	**1**	**1**	**1**		
	Attain annual increase in market share in Norway of v%	**2**	1	1			
	Increase export by w%	**1**		1			
	Increase volumes	**1**			1		
G3	**Survival:**	**2**	**1**				**1**
	Secure jobs	**2**	1				1
P	**Policies:**	**2**	**1**				**1**
P1	Maintain production in Norway	**2**	1				1
P2	Play a social role in the local community	**1**					1

The three main categories, profitability, growth and survival, were derived during the analysis of the data. They are in accordance with literature describing goals for business organisations (Anthony & Dearden, 1976; Cyert & March, 1963; Simon, 1976).

The main superordinate goals in Alpha were related to profitability. Since Alpha is a well-established business enterprise, this finding was expected. Table 6.1 shows that all interviewed managers were concerned about profitability and aware that profitability was related to increasing income (G1.1) and reducing costs (G1.2). The three strategic managers (M1, M2 and M3) were also concerned with growth, both in Norway and abroad.

The table reveals that the managers with roles at the strategic level in the organisation (M1, M2 and M3) were most familiar with the overall organisational goals. These managers provided documents listing the goals, and they referred extensively to these documents during the interviews.

Several managers mentioned that the enterprise had a strong financial standing. For example, M1 stated: “Alpha is a solid enterprise which has never had a deficit year, even in times of recession”. Perhaps, therefore, the managers seemed not to be concerned with financial risk. However, the CEO was concerned about the long-term survival of the enterprise. This goal was expressed implicitly in several ways during the elicitation of the CSFs, such as in connection with expansion abroad to stay competitive in a market with increasing competition from low-cost countries, see, Table 6.2, strategic activities. During the elicitation of goals, however, the CEO mainly expressed the long-term survival of the enterprise in connection with his efforts to secure the jobs for his employees (G3).

However, even though it is more profitable to produce windows abroad, the owners had a policy to maintain production in Norway (P1). Manager M5 also mentioned that the owners played a social role in the community (P2) by supporting several cultural activities and buildings.

Table 6.1 shows that the managers were aware of the organisational goals even though they did not all remember the actual figures or formulation of the operational goals. The managers' different roles probably also influenced their answers. For example, it is natural that the sales manager mentioned more goals related to sales than the other managers did.

It was difficult to make some of the managers talk about organisational goals. For example, manager M4 repeatedly referred to the business idea when asked about goals, while some managers mentioned some CSFs when asked about goals. In the feedback meetings, I explained why I had moved some of their "goals" to the CSF categories, and the changes were accepted.

In connection with the elicitation of goals, I noted that all managers mentioned Alpha's business idea, which is that Alpha shall be in the front regarding production, development and marketing of eco-friendly and secure windows and doors with accessories. The managers knew the business idea by heart, and it was among their first considerations when asked to describe Alpha. This indicated that the business idea was very much present in the managers' minds on a daily basis.

5.3 Analysis of critical success factors

Table 5.2 gives an overview of the critical success factors mentioned by the interviewed managers. The table is organised in the same manner as Table 5.1. I have categorised the factors into internal and external factors. Table 5.2 reflects that the interviewees were managers at the head quarter. The internal factors are categorised into strategic and tactical activities. The tactical activities include the monitoring of operations, but CSFs at the operational level are not included. Operational details will be discussed in connection with the analysis of work processes in Chapter 7 and related to the CSFs in Table 5.2 when I discuss the effects of the implementation of the ERP system in Chapters 7 and 8. The external factors in Table 5.2 are not controllable, but some of them can be influenced by the managers' and employees' activities. For example, customer satisfaction cannot be controlled, but the level and the development of customer satisfaction can be measured and related to the activities.

Table 5.2 Critical success factors mentioned by managers in Alpha

Critical success factors:		Sum	M1	M2	M3	M4	M5
Internal							
CSF1	**Strategic activities**	**5**	**1**	**1**	**1**	**1**	**1**
CSF1.1	Expand production capacity abroad	**2**	1				1
CSF1.2	Improve supply chain management	**5**	1	1	1	1	1
	Integrate data through the supply chain	**5**	1	1	1	1	1
	Complete order registration	**3**			1	1	1
	Optimal exploitation of capacities among factories	**2**			1		1
	Reduce time of products in production	**5**	1	1	1	1	1
	Reduce stocks	**3**			1	1	1
CSF1.3	Train employees in global view of the enterprise	**3**		1	1		1
CSF2	**Tactical activities - effective supply chain**	**5**	**1**	**1**	**1**	**1**	**1**
CSF2.1	Integrated planning and coordination at the enterprise level	**4**	1		1	1	1
CSF2.2	Sales planning	**3**		1	1		1
	Brand towards architects and consultants	**1**		1			
	Evaluate capacity (avoid overselling)	**2**			1		1
	Focus on profitable customers and products	**2**		1			1
CSF2.3	Production planning	**2**			1		1
	Optimise exploitation of capacities in each factory	**2**			1		1
	Coordinate delivery of specialised products	**1**					1
CSF2.4	Procurement planning (contracts)	**3**		1	1	1	
	Set standards towards external suppliers	**2**			1	1	
	Specify needs from Alpha process perspective	**1**				1	
CSF2.5	Transportation planning	**2**			1		1
	Coordinate supplies to factories	**1**			1		
	Coordinate deliveries to customers	**1**			1		
CSF3	**Monitoring of operations**	**5**	**1**	**1**	**1**	**1**	**1**
CSF3.1	Monitor sales/customers	**2**				1	1
	Demand for products, evaluation of orders/capacity	**2**				1	1
	Profitability of products	**2**				1	1
	Profitability of customers	**2**				1	1
CSF3.2	Monitor production processes (learning)	**5**	1	1	1	1	1
	Development capacity exploitation/bottlenecks	**1**		1			
	Development delivery on time (x%)	**3**	1		1	1	
	Development deficits during production	**3**	1	1	1		
	Development of complaints (max. y% of sales)	**1**			1		
	Development overtime (max. z%)	**1**			1		
	Development absence through illness (max. v%)	**1**			1		
External							
CSF4	**Customers**	**2**		**1**	**1**		
	Perception of Alpha quality, Alpha brand (price/quality)	**2**		1	1		
	Perception of satisfaction (quality, service, delivery dates	**1**			1		
CSF5	**Competitors**	**4**	**1**	**1**	**1**		**1**
	Structural changes in Scandinavia, buyouts	**1**	1				
	Market shares	**2**	1	1			
	Products, costs and prices	**3**	1	1			1
CSF6	**Authorities**	**2**			**1**		**1**
	Rules, product requirements, energy regulations	**1**			1		
CSF7	**Economy**	**2**			**1**		**1**
	General economic conditions	**1**			1		
	Building activities	**1**			1		
	Interest rates	**1**			1		
	Raw material prices	**1**					1

The strategic activities were related to the efforts mentioned by the CEO to meet the increasing competition from low-cost countries. The CEO monitored the competitors and the structural changes in the market (CSF 5), among others, to identify possibilities to expand the production capacity abroad (CSF 1.1). As shown in Table 5.2, all interviewed managers were aware that a CSF related to the profitability goal was improvement of the supply chain (CSF 1.2). By supply chain, they meant the *extended* supply chain, the value chain including external suppliers and customers. Furthermore, the improvement was related to “global optimisation”, the optimal utilisation of the production capacity across factories, including the factories abroad. When the managers discussed optimisation, they also considered the transportation costs of raw material, supplies among units and deliveries to customers.

The investment in the ERP system was heavily related to the CSF of improved supply chain management (CSF 1.2). One of the CSFs mentioned in the sub-categories was the integration of data through the extended supply chain. There should be no manual handling of data after the data were entered into the ERP system at the source. The managers expected that integration of data in the ERP system would reduce “managerial lead times” because data would be immediately accessible to the interested parties in the data base. Furthermore, a major problem with the current system applied in the sales process was that an order could not be specified completely. I will analyse the details of this problem in Chapter 7. A CSF in connection with the design and implementation of the ERP system, therefore, was that the new sales module should support a complete registration of sales orders. The new sales module was expected to reduce misunderstandings with the customers and the production managers, thus also reducing the time to close orders. With a production-planning module and a totally integrated ERP system to support the management of the extended supply chain, the time products spent in production was expected to be reduced, and in particular the administrative lead times were expected to be reduced.

A CSF mentioned in connection with the “global optimisation” was to train the factory managers and the employees at each factory to have a “global view of the enterprise” (CSF 1.3). The managers and employees should understand that even though the production costs at each unit might increase after the implementation of the ERP system, the centralised planning of production orders to each unit was optimal from an enterprise point of view.

As shown in Table 5.2 under the label of tactical activities, the managers and employees attempted to optimise the use of resources before the implementation of the ERP system. They had some kind of integrated planning and coordination with a corporate planner allocating orders to the production units (CSF 2.1), but the detailed production plans at each factory was planned by local planners. The system supporting the planning showed the utilisation of production resources at each unit week by week.

When the sellers accepted orders, they evaluated the production capacity to avoid overselling (CSF 2.2). The sellers also attempted to focus on profitable products and customers (CSF 3.1), but they lacked valid data to do so effectively.

The factory managers attempted to optimise the use of resources in each factory (CSF 2.3), monitoring the exploitation of the production capacity and the use of overtime. A special challenge was the production of specialised products so that these products were recognised by sellers, priced correctly and delivered together with the rest of the order. The quality of the production processes was carefully monitored (CSF 3.2), focusing on indicators such as the percentage of deliveries on time and the development of deficits and customer complaints.

The procurement manager had a process perspective on his activities (CSF 2.4). He was responsible for the negotiations of contracts with the suppliers and was concerned about reducing stocks. In the contracts, he was very specific regarding the quality of raw materials and components, particularly the quality of the wood. Furthermore, he specified the delivery terms so that raw materials were delivered when needed in the production processes to reduce stocks. He stated: "… It is important to catch Alpha's total procurement needs and present them as premises in our contract negotiations. … We must set standards towards the suppliers."

Table 5.2 shows that the managers focused on integrated planning and coordination and on optimal exploitation of resources even before the implementation of the ERP system. However, the legacy systems prevented them from organising the work processes effectively, and the legacy systems did not give them the data quality they wanted to support their decision making.

6 Implementation of an ERP system in Alpha

In my research question, I ask how top managers' involvement in ERP system projects can affect the implementation processes and subsequently organisational effectiveness. In this chapter, I deal with the first part of my research question, that is, how the managers' involvement affected the ERP system implementation process. Thus, in this chapter, I analyse the ERP system implementation process in Alpha in detail.

As described in Chapter 4, I collected a considerable amount of data, both from multiple interviews and documents that describe the implementation processes. A main challenge during the analysis, therefore, was to get an overview of the data in order to search for patterns, similarities and differences among the processes and objects under investigation.

The ERP-system in Alpha is made up of several modules, and I have studied them in either retrospect or real time. Table 6.1 provides an overview of the sub-systems and how I studied them.

Table 6.1 The modules constituting the ERP system in Alpha and how they were studied

Module	Studied in
Accounting module	Retrospect
Procurement module	Retrospect
Warehouse Management module	Retrospect
Production-planning module (PM)	Retrospect and real time
Sales module	Real time
Production-planning module (PM2)	Real time

I started my collection of data during the implementation of the production-planning module PM. Therefore, the implementation of this module I studied in both retrospect and real time. The implementation before this module I studied entirely in retrospect, and the implementation of the subsequent modules I studied in real time.

I decided to base my presentation and analysis on the adapted and extended PSIC (Punctuated Socio-technical Information system Change) model developed by Lyytinen and Newman (2006, 2008). This model was developed explicitly to support explanations of changes in information systems. The PSIC model gives a useful overview of a longitudinal process, but the model does not represent implementation processes that involve sub-projects. Nor does the model include intermediary outcomes of longitudinal processes. It was, therefore, necessary to extend the PSIC model to present implementation processes that integrated several sub-projects and to reflect the outcomes of sub-projects. The original PSIC model, and my adaptation and extensions of the model are presented in Appendix II. In this chapter, I apply the extended version of the PSIC model and therefore, I recommend reading Appendix II before continuing to read this chapter.

Figure 6.1 gives an overview of the implementation process using my extended version of the PSIC model. In the following, I describe the processes in detail with references to the figure. The term process can be defined in various ways, see, for example, Van de Ven (1992). Related to the implementation, a process is defined as a sequence of events and actions that describes how things change over time. First, I describe the antecedent conditions. Then I describe the management of each sub-project.

6.1 Antecedent conditions

In accordance with their goals, the top managers' reasons for implementing an ERP system were to increase organisational effectiveness, particularly by attempting to optimise the flow of materials through the supply chain of all factories, improving services to the customers and having access to more accurate and updated data. The Y2K problem implied that the implementation process was initiated in 1999. By then, the top managers had already started to prepare for the implementation in ways such as establishing projects to standardise the names and numbers of the many components that were used in the factories' production processes. In addition, the top managers had started the search for an appropriate vendor of ERP system packages.

A vision was developed by the top managers to exploit the potential of ERP technology to increase organisational effectiveness through more effective business and administration processes.

The managers had realised that it might be difficult to find ERP technologies to support the production-planning process in Alpha. One of the main reasons for implementing an ERP system was to centralise production planning to improve the utilisation of capacities in the various production units. As explained in Chapter 5, Alpha produces windows by measures: windows with variable breadth and height, termed VBH products. In 1999, most ERP packages were developed for the production of discrete predefined parts, and they were not well suited to support process industries.

Because the managers were aware of the problems in finding a suitable package in 1999, the invitation to tender included a "case" explaining VBH production, and the managers demanded that interested vendors should explain how they would handle the problem of representing VBH planning and production in the ERP system. After a thorough selection process, a vendor was chosen, and in the contract, the vendor agreed to develop a custom-made production-planning module (PM) at a fixed price, in addition to fulfilling other conditions. The ERP package will hereafter be named Pack.

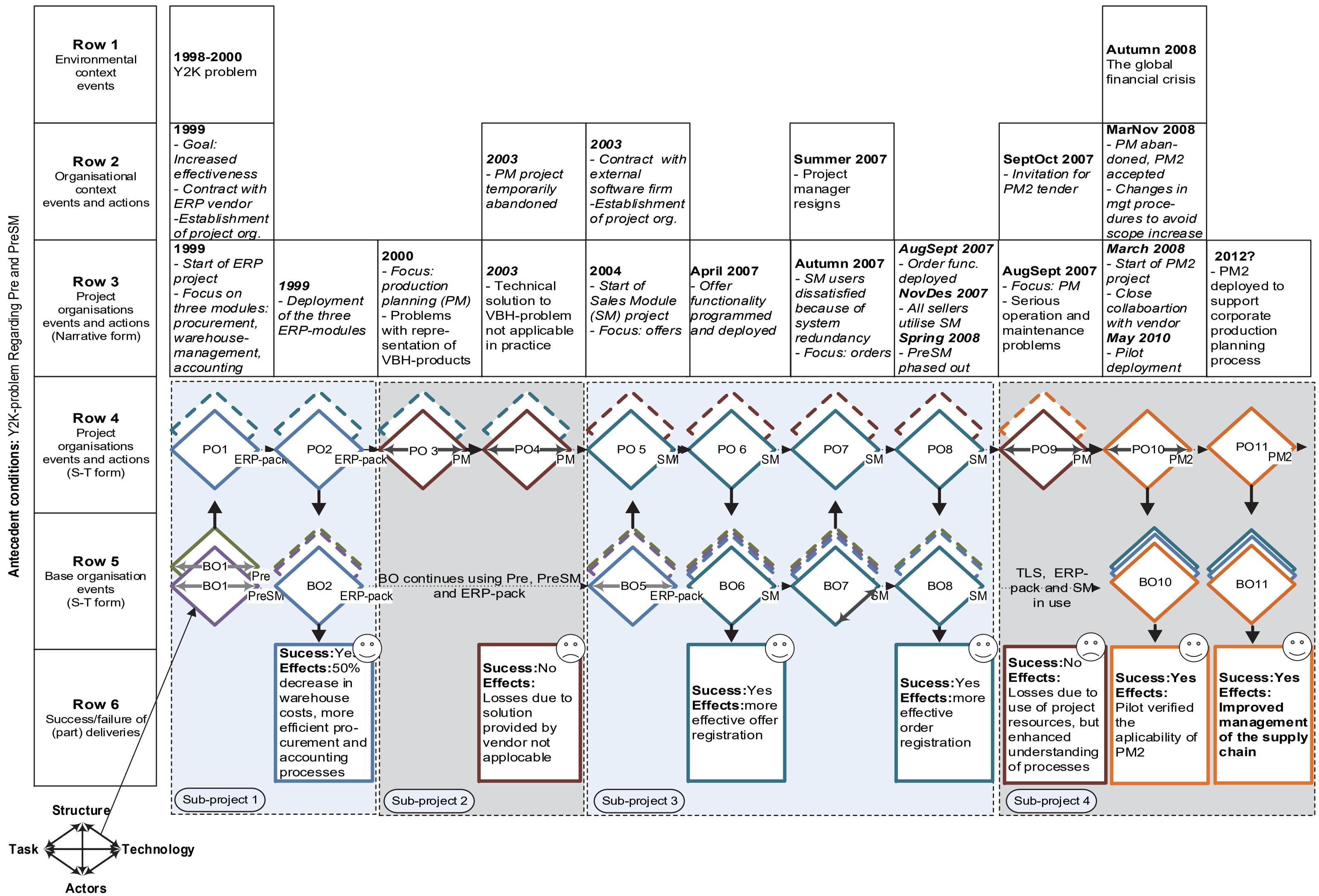


Figure 6.1 Implementation of the ERP system in Alpha

6.2 The management of each sub-project

In this section, I describe how the top managers in Alpha influenced the implementation project. Furthermore, I analyse if and how a project management methodology, such as the one accounted for in my conceptual framework in Chapter 3, was applied during the ERP system implementation project. In addition, I make several references to the two dimensions of Wysocki's characterisation of projects (Wysocki, 2007). These dimensions were also presented in my conceptual framework. They are a certainty – uncertainty continuum for project goals and a certainty – uncertainty continuum for requirements and solutions. Finally, I apply the five approaches to product development, also developed by Wysocki (2007): linear, incremental, iterative, adaptive and extreme. These approaches were also described in Chapter 3.

6.2.1 Sub-project 1: implementation of three modules from the ERP package

The Y2K problem represented a perceived serious gap between task and technology, termed BO1 in Figure 6.1, and was the main reason that the ERP project was initiated in early 1999. A project organisation with members from Alpha and the ERP system vendor was established, and it was decided that the project group should start with the configuration of three standard modules (PO2/BO2): accounting, warehouse management and procurement. The ERP modules represented "best practice" in the three areas, and therefore the top managers expected that the configuration of the modules to the Alpha context would increase effectiveness in the pertaining business processes.

During the project establishment, the top managers took care that a steering committee, a project manager and project team members were appointed to the project. The steering committee consisted of two top managers including the CEO. The members of the project organisation were a very competent team, consisting of internal members who were experts on the production-planning processes, and external members from the vendor who were experts on the ERP technology. However, the top managers did not take care that a formalised business case or a project charter was developed.

Clear goals and requirements had been defined and, as described above, pre-projects had already been undertaken to standardise components among the production units. A linear implementation strategy was chosen.

The configuration of the modules was completed within time and budget and deployed in the base organisation without major obstacles. One of the reasons was that the internal members of the project organisation were well prepared for the job and collaborated well with the external consultants who were experts on the ERP package.

6.2.2 Sub-project 2: development of the first production planning module

The purpose of the PM module project was to increase the effectiveness of production planning. The top managers wanted to replace the current decentralised production-planning process with a corporate production-planning process, supported by the production-planning module PM. The task – technology gap BO1 in Figure 6.1 is thus an opportunity gap (light grey arrows).

The goals were clear, but the requirements and solution were unclear, and the complexity of the module was very high, involving many components and interdependencies throughout the whole supply chain. Still, the top managers decided to hand over the development of the PM module and the control thereof to the vendor.

The PM sub-project commenced in year 2000 and built on the contract with the vendor to deliver a custom-made production and planning module embedded in the ERP package. A comprehensive effort was made to describe the VBH products from a generic point of view and to represent the products in a form that could be programmed using the technology of the ERP package.

There was no close collaboration between internal and external members to develop the requirements specification, and programming the module proved to be much more cumbersome than anticipated, but in 2003 the consultants from the ERP vendor made a delivery (PO4).

The delivery solved the problem of handling VBH products from a theoretical point of view, but when the solution was tested in a realistic production-planning setting, it turned out to be inapplicable. The module was unable to process a production plan and update changes fast enough to satisfy the production planners' needs. The solution was not deployed, and the contact with the vendor regarding the development of the PM module was abandoned.

The appropriate implementation strategy for sub-project 2 would have been the iterative approach. However, the top managers decided to outsource the development of the PM module to the vendor. The lack of collaboration between the internal project members and the consultants from the vendor is probably the reason why the inappropriateness of the PM module was not detected during the development phase.

The top managers decided to attempt to improve the vendor's solution with in-house staff and allocated resources and time to the project. Furthermore, the top managers approved change requests from several functional managers. However, the change requests were not handled according to recommendations from relevant project management methodology. For example, the project was not required to conduct cost-utility analysis, risk evaluations and scope adjustments related to the change requests.

For several years, the opportunity gap between task and technology regarding the production-planning module remained unexploited (PO10). However, functional managers from the base organisation continued to demand special solutions to support their particular processes, and the top managers continued to approve the change requests. Consequently, the internal members of the project organisation continued to find solutions and to programme additional code to the ERP package. The project managers repeatedly requested more time to improve the PM module, and the top managers repeatedly consented to their requests. This outcome occurred because the top managers had invested considerably into the solution, and both the project members and the top managers believed that a relatively small portion of work remained before the PM module would be operable. Hence, the fear of losing their investments in the PM effort made them continue to invest into the solution.

The PM sub-project was allowed to continue for several years without delivering deployable functionality to the base organisation. Unfortunately, some of the additional programme coding involved the programming of changes in the modules that would make later updates of the ERP package difficult and costly.

In 2008, the PM effort was finally terminated by the top managers. The development effort and the subsequent improvement effort did cost a great deal of money, both for the vendor and for Alpha in terms of human resources invested in the sub-project.

6.2.3 Sub-project 3: development of the sales module (SM)

After the vendor's delivery of the PM solution, the top managers decided to establish a project group to develop the requirement specifications for a new sales module (PO5). There were two main reasons for starting the SM sub-project: 1) The sellers were dissatisfied with the legacy system because products were indicated by long codes that did not describe the product characteristics. Furthermore, the sellers were dissatisfied because the legacy system did not enable them to specify orders completely or to provide an accurate graphic illustration of the products. 2) The production managers were dissatisfied with the legacy sales system because it allowed sellers to sell products that exceeded the production constraints without realising the fact until the order was about to be produced.

Because of the characteristics of the products (made by measures), a custom-made module had to be designed and built. To satisfy the customers' demands for integration of shared processes, a web-based solution was chosen.

The goals were clear, while the requirements and solution were unclear. The members of the project organisation were a very competent team with experienced sellers (end users), members of the IT department and external expert programmers.

A combination of project management approaches was chosen. The project was decomposed into functionality for offers and confirmed orders. These functions were handled sequentially; that is, the superordinate strategy was incremental. Each function, however, was developed using an iterative strategy in close cooperation with the selected sellers.

Iterative processes were used to manage the projects, and iterations were applied not only as regards software development, but to discuss desired changes in the sales process as well.

A selected group of sellers were invited to test SM in a real production setting, but soon most sellers used SM to prepare offers. After a few months, orders pertaining to the offers registered in SM started to arrive. However, with the functionality regarding order registration still pending, the sellers had to re-enter data for the orders in the legacy order system, here called PreSM. This cumbersome procedure resulted in dissatisfaction: that is, a people – technology gap (BO8).

Efforts were then made to develop the order functionality fast, and the deployment of this functionality effectively solved the misalignment (PO9/BO9). Offers could then be transferred to order status just by changing the status of the offer to an order. As soon as SM worked as intended for registration of both offers and orders, the legacy order system, PreSM, was phased out (BO9).

The development and deployment progressed mainly according to plan. The effects of the SM module were expected to improve services to the customers (graphical presentations of the offered/ordered products, shared processes) in addition to more efficient internal procedures.

6.2.4 Sub-project 4: development of the second production planning module

In 2007, it was clear that the PM module would probably never work satisfactorily. The top managers considered the corporate production-planning module essential to increase effectiveness. In 2008, they invited a local vendor of software solutions to tender for a production-planning module, PM2. The vendor made an impressive offer, and soon after PM was discarded (PO10).

The steering committee established a pre-project assessing whether the solution proposed by the vendor could be integrated with the ERP package and SM to achieve the project goals. The top managers together with key employees concluded that it was feasible to achieve Alpha's goals through the implementation of PM2, and thus a new project, sub-project 4, was established.

When the project started, goals were clear, while the requirements and solutions were partly clear because of the experiences with PM, SM and the pre-projects that specified requirements and assessed the proposed solution. However, the module was very complex, involving numerous components and interdependencies with other modules across the whole supply chain. Again, the members of the project organisation were a very competent team, comprising internal experts on production planning and IT and external experts on the selected software technology.

Based on the experiences with the PM sub-project and the failed attempts afterwards to find a solution, the top managers decided to change the project management strategy, that is,

- stick to the goals and allow no scope increase (extensions of project scope),
- test the solution in a pilot unit before deployment,
- take change requests into consideration only when key functionality has been implemented.

In contrast to the implementation of PM, the main development strategy for PM2 was iterative. The deployment strategy was incremental.

PM2 was first deployed in a pilot factory. One of Alpha's factories was selected as a pilot factory because it produced a broad range of VBH products. The project progressed throughout the organisation according to the established strategy, except for minor time delays.

6.3 Summary of the implementation process

The project management strategy for the PM module in sub-project 2 was clearly inadequate. The main reason for the failure and losses of this sub-project was that the inappropriateness of the solution was not detected until after the module had been programmed. In 1999, it was probably impossible to satisfy the top managers' solution requirements with the ERP vendor's technology, but with a more iterative development strategy as applied in sub-projects 3 and 4, the inadequacy of the development attempts would have been detected earlier and losses reduced.

The model of the implementation process in Figure 6.1, along with the detailed descriptions, demonstrates the importance of the top managers' involvement in ERP projects. In Alpha, the top managers ensured that the internal members of the project organisation were highly competent and well prepared for the job before the collaboration with the external members of the project organisation. The top managers also allocated sufficient resources to the projects. In addition, they had prepared the changes in the organisation so that the employees understood and supported the needs for new computerised systems. I believe that the top managers' involvement considerably facilitated the base organisation's implementation of the modules related to sub-projects 1, 3 and 4.

In accordance with the business concept of being the leading producer of windows and doors, the managers saw the need for custom-made modules. They adapted the ERP package modules to their needs when the modules represented "best practices" they could adopt in areas in which they did not have competitive advantages, such as accounting, procurement and warehouse management. In areas in which they had special knowledge, such as selling and producing VBH products, they designed and developed the technology to fit their needs and strengthen Alpha's competitive advantage.

7 Effects of implementing the ERP system

In my research question, I ask how top managers' involvement in ERP system projects can affect the implementation processes and subsequently organisational effectiveness. In Chapter 6, I dealt with how the managers were involved in the ERP implementation project. In this chapter, I will answer the part of my research question that deals with organisational effectiveness. The CSF framework developed in Chapter 5 serves as my context-specific standard of comparison to assess effectiveness. Furthermore, I will apply the business process modelling technique presented in Appendix III.

In Alpha, the managers aimed to improve effectiveness in their work processes. To do so, they implemented an ERP system as described in Chapter 6. In this chapter, I analyse effects that are related to the implementation of the ERP system. Table 7.1 provides an overview of the sub-projects and their deliveries and purposes.

Table 7.1 Project goals and effect goals for the four sub-projects

	Sub-project 1	Sub-project 2	***Sub-project 3***	***Sub-project 4***
Project goal /result:	Deliver ERP system modules to support: - Accounting - Procurement - Warehousing	Deliver ERP system module to support the production planning process: PM (production planning module)	***Deliver ERP system module to support the sales process:*** ***SM (sales module)***	***Deliver ERP system module to support the production-planning process:*** ***PM2 (production planning module)***
Effect goal:	To increase the effectiveness in the accounting, purchase and warehousing processes	To increase the effectiveness in the production-planning process	***To increase the effectiveness in the sales process***	***To increase the effectiveness in the production-planning process***

I studied sub-project 1 in retrospect, and I have no details regarding the processes, but according to Alpha's top manager, the work processes related to accounting, procurement and warehouse management became more effective. The managers reported several early gains attributed to the new modules. For example, after six months, a 50 percent decrease in inventory costs of goods was reported, amounting to several million NOK. After one year, the implementation had increased the efficiency of the accounting and procurement processes and resulted in substantial cost reductions.

The first production-planning module was never deployed. Details regarding the losses were impossible to obtain. The positive effects of sub-project 2 were that the managers learned details about their work processes and how they could be improved. Furthermore, the negative experiences within sub-project 2 provided a learning experience in how to prevent potential failures and deal with them if they should occur again.

In this chapter, I focus on the effects of sub-project 3 and sub-project 4, which I have followed in depth. In the table, they are indicated in bold and italic text.

I have described and analysed Alpha's sales process and production-planning process as they were before and after the implementation of the ERP system modules SM and PM2. Furthermore, I identified the changes that occurred and evaluated whether these changes increased effectiveness or not. Hence, my focus was on the changes in the work processes and not the technical details in the basic operation of the ERP system.

7.1 How to analyse effects

In this section, I will explain how I have analysed effects derived from Alpha's implementation of sub-project 3 and sub-project 4. I have decomposed Alpha's sales process into three sub-processes: offer registration, offer follow-up, and order registration. In total, I modelled and described eight processes, as shown in Table 7.2. These process models are enclosed in Appendix IV.

Table 7.2 Overview of work processes analysed in this chapter

The sales process:	**The production planning process:**
Offer registration: - offer registration before SM - offer registration after SM Offer follow-up: - offer follow-up before SM - offer follow-up after SM Order registration: - order registration before SM - order registration after SM	- Production planning before PM2 - Production planning after PM2

To develop these models, I build on an existing modelling technique, called RIC (Iden, 2009). In Appendix III, I explain why and how I have adapted and extended the RIC technique. I provide extractions from the process models in this chapter. Therefore, I recommend reading Appendix III before reading this chapter.

Together, the process models and the managers' goals and perceptions of CSFs serve as a point of departure to analyse changes and effects. In Figure 7.1, I illustrate three types of analyses and what is required to conduct them. The three analyses are indicated on each side of the triangle, and in this thesis I have conducted analysis II and III (the managers in Alpha conducted analysis I). The requirements are noted on the corners and in order to conduct the analysis, I compare the process models indicated in the corners pertaining to each line. Each analysis is explained below the figure.

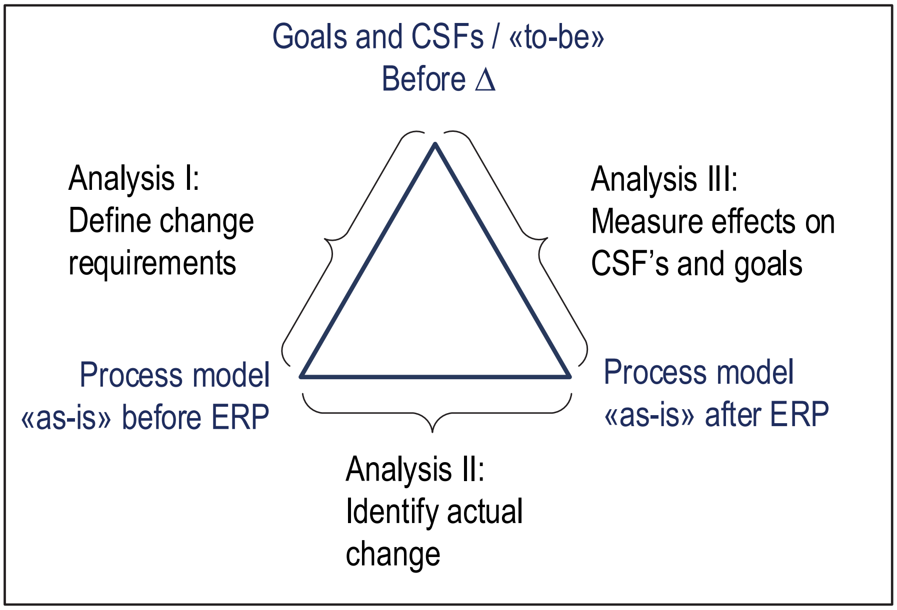


Figure 7.1 Overview of analyses

The purpose of the first analysis is to define change requirements. Project managers apply process models "as is" and "to be" in order to establish a common point of departure and a common direction for the changing organisation. By comparing processes "as is" and "to be" one establishes change requirements. The project managers and project members in Alpha defined their change requirements, and I have cited these requirements in the introduction to each work process analysis.

The purpose of the second analysis is to identify actual changes. In this thesis, my aim was to analyse effectiveness in the organisation, and for that I needed to first establish if the implementation of an ERP system module resulted in actual changes in the work processes. To establish if and how such changes had occurred, I compared the original work process model to the changed work process model, and thus I was able to identify the changes.

The purpose of the third analysis is to analyse if and how changes in a work processes may have affected CSFs and goal achievements. To analyse effects in this study, I first identified changes that probably derived from the ERP system implementation project. Thereafter, I compared the changed work-process model to the critical success factors and goals. I analysed how these actual changes in the work processes were likely to have affected the CSFs and goals in Alpha.

Furthermore, I divided my analysis processes into three steps, as indicated in Figure 7.2. These three steps have guided my analysis of the work processes, presented in Table 7.2. Each step is described below.

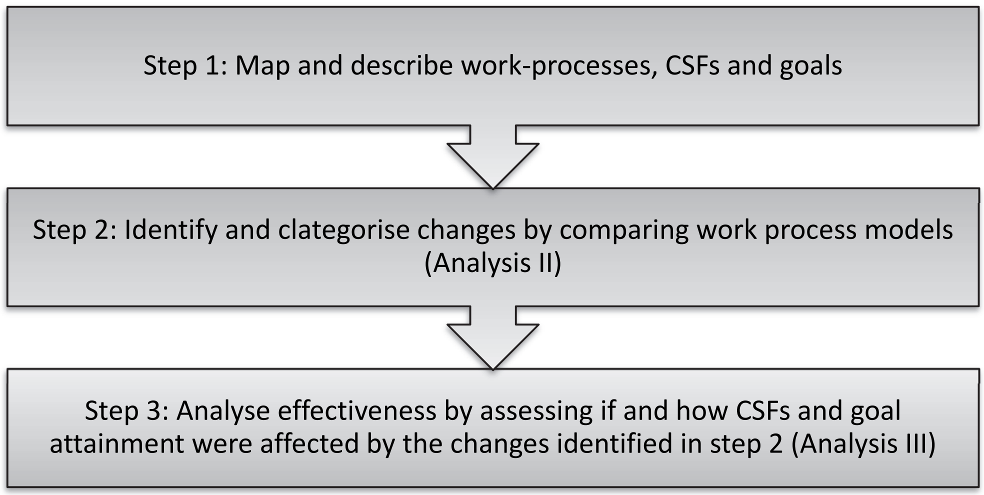


Figure 7.2 A three-step analysis

In step 1, I modelled and described the work-processes, CSFs and goals as required in order to conduct step II and III. In step 2, I identified the actual changes that had occurred by comparing the models developed in step 1. As explained in Appendix III, the changes were classified into three different types: modification, redundancy or innovation (new). Furthermore, I analysed if and how the four change variables (task, structure, technology and actors) (Leavitt, 1965), were affected by the change. In step 3, I analysed if and how CSFs and goals were affected by the changes identified in step 2. To assess whether increased effectiveness was achieved, I compared the detected changes in the new work processes to the goals and critical success factors mentioned by the managers.

7.2 Analysing effects in the sales process

Alpha's managers aimed to increase effectiveness in the sales process to improve supply chain management (CSF 1.2), particularly by enabling the sellers to describe orders completely in the ERP system. In addition, the managers wanted to improve services to customers and to exploit the opportunity to enhance their understanding of the customers' behaviour.

Several initiatives were taken. However, in this analysis, I focus on three change requirements that Alpha's sellers and managers, involved in sub-project 3, emphasised as necessary to successfully implement an ERP sales module.

The change requirements (CR) were:

- ✓ CR 1: Simplify product registration and visual representation of products
- ✓ CR 2: Improve the handling of special-work products
- ✓ CR 3: Digitalise the offer follow-up process to obtain data for management support

In Alpha, the change requirement analysis was conducted based on the discrepancy between the current work processes and the goals. Change requirement 1 was planned to simplify the registration process and improve graphic product illustrations according to modern system standards – in other words, to move from a code-based to a window-based system. Change requirement 2 was planned to ensure that orders containing special-work products were identified before the orders were about to be produced. Change requirement 3 was implemented to increase managers' access to critical data. Therefore, by evaluating the effect of these changes one might gain insights into whether the planned efforts worked as intended.

I modelled Alpha's sales process based on several interviews and informal conversations with sellers, as described in Chapter 4. As mentioned above, the sales process before and after SM consisted of three sub-processes as illustrated in Figure 7.3.

Figure 7.3 The sales process in Alpha

The entire sales process is comprehensive. Therefore, in this chapter, I have chosen to present only extracts of the process models focusing on the three change requirements mentioned above.

I first analyse "product registration and visual representation of products" and "how the sellers handled the sale of special work products". These tasks were usually performed during the offer registration process. However, they were part of the order registration process if a customer ordered products without going through the process of assessing an offer. The follow-up sub-process was always related to an offer. This process was conducted to increase the number of offers that resulted in orders.

7.2.1 Product registration and visual representation of products

In this section, I analyse changes in the activities related to product registration and visual representation of products. These activities are highly related because the system utilised registered product data to generate visual representations. Therefore, accurate product registrations are necessary to obtain accurate visual representation of products.

The sellers expressed that one of the main challenges with the legacy system was the cumbersome registration of product specifications, and one seller put it like this:

> *"Several printouts have to be made in order to check the registered specifications. Consequently, a whole forest must be cut down before the offer is correct and can be sent to the customer. It is like this because one cannot see what is actually registered."*

Step 1: Modelling and describing product registration and visual representation of products

As explained in Chapter 5, products are custom-made in Alpha (VBH-products). This implies that the registration of each product may be different from any other products registered previously. Hence, it is not possible to select products based on a collection of standard products pre-registered in the database.

In Figure 7.4, I present extracts of the process models regarding *Product registration and building visual representation of products*, before (left side) and after (right side) the deployment of SM. To maintain the order of the process models each model was given either the "pre" or "post" prefix, indicating whether the process was modelled before or after the implementation of an ERP system module.

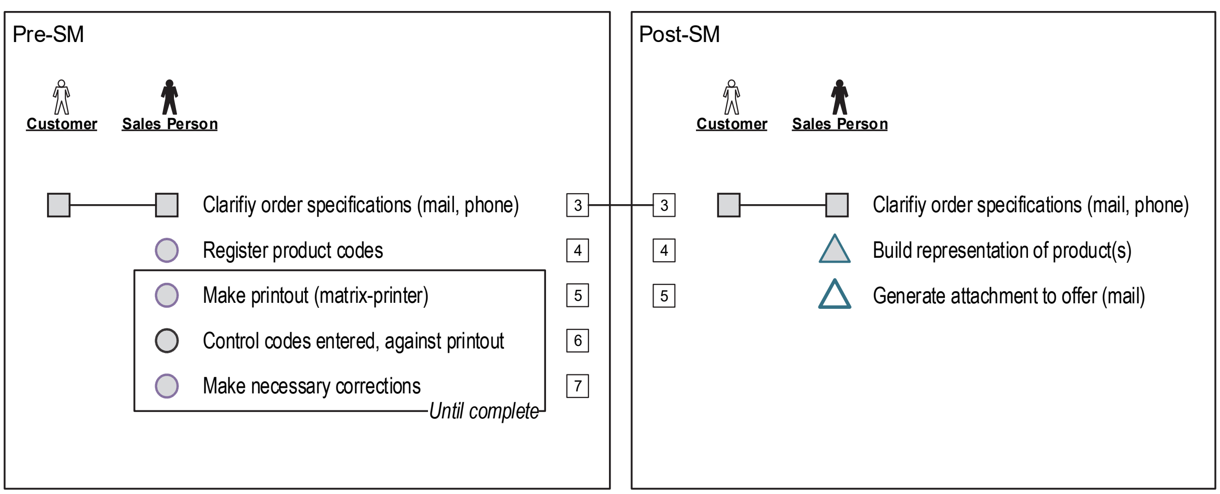


Figure 7.4 Process model illustrating changes in registration and visualisation of products

This figure illustrates how activities were performed before and after the implementation of the ERP sales module.

Before and after the deployment of SM, the sellers clarified order specifications with the customer (activity 3). The next activities dealt with entering the order specifications into the system, and these activities differ substantially in the pre-SM and post-SM processes.

Before SM, sellers entered product codes into the pre-SM system. The codes constituted a list representing window specifications. This list appeared on the computer screen only, that is, it was not possible to make a printout of the list. However, to provide graphic illustrations of the products specified in the codes, the sellers made printouts from a matrix printer. The illustration only appeared on printouts and not on the screen. The sellers checked that the illustrations on the printout corresponded with the product specifications received from the customer. The following activities: printout, comparisons, and corrections were reiterated until the offer/order specifications were registered as intended. Thereafter, the printouts were sent to the customer for verification, usually by fax.

The product illustrations enabled by the pre-SM system were not very detailed and could only give a limited visualisation of the products. For some products, such as bevel-angle windows, the sellers had to draw parts of the product specifications manually. This made it difficult for both sellers and customers to obtain an accurate impression, based on the printed illustrations.

After the deployment of SM, sellers were able to construct graphic window product illustrations on the screen. Thus, the legacy product registration process was replaced with a new and innovative process of building detailed graphic product illustrations, enabled by functionality in the ERP system module. One seller explained it like this:

> *"Before we did not have the possibility to build orders on the screen in the way we do today. Before, we even had to do some of the drawings manually. It used to be a difficult task, and even just the drawing part could take hours in a big and complicated order*."

The new way of registering products implied "drag and drop" functionality, which was far less time-consuming than it was before SM. Therefore, under SM, sellers were able to register a product, e-mail a preliminary offer to the customer, and obtain immediate feedback while talking to the customer on the phone. Furthermore, sellers were able to see whether specifications were registered as intended as the construction process unfolded. Detailed visual representation of products were mailed to the customers and thus enabled customers to provide necessary feedback to the seller. This feature completely altered the sellers' daily work and interactions with their customers. One seller described the new work process like this:

> *"An order may be completed, without having to make printouts, split and add drawings before sending. Everything is now done in SM, and we can make simple orders while talking to the customer on the phone, send it and receive feedback during the conversation."*

Step 2: Changes in product registration and visual representation of products

Next, I identify, categorise and analyse the changes by comparing the process models of the work process from before and after the deployment of SM.

Figure 7.4 provides a visual representation of differences between the work processes before and after SM. Therefore, I apply the modelling technique I developed in Appendix III, to support my comparison of the work processes.

In Figure 7.4, redundant activities are indicated with a circle and new activities are indicated with a triangle. Supported by the new and customised sales system, the work process changed and the iterative activities involved in registration of product codes (activity 4-7 in the pre-SM process) were replaced by a new activity (activity 4 in the post-SM process). An overview of the changes illustrated in Figure 7.4 are listed in Table 7.3.

My analysis of the entire offer registration process models indicates that not only the activities, but also the equipment used in the offer-registration process, such as matrix printers, copy paper, faxes and couriers became redundant. In the post-SM process, sellers sent offer documents by mail, and one seller explained the change like this: "It's so clear and easy, it's not like you have to interpret what's written in a bad telefax."

Table 7.3 List of changes in product registration and visual representation of products

Changes in product registration and visual representation of products
1. Activity 4 in the pre-SM process was made redundant (register product code)
2. Activity 4 in the post-SM process was new (build representation of product)
3. Activity 5 in the pre-SM process was made redundant (make printout)
4. Activity 6 in the pre-SM process was made redundant (control codes against printout)
5. Activity 7 in the pre-SM process was made redundant (make necessary corrections)
6. Activity 5 in the post-SM process was new and automatic (automatic generation of attachment to offer)

I find that all four change variables (Leavitt, 1965) were affected by the changes listed in Table 7.3. The technology variable was affected because legacy technologies were replaced with SM. The task variable was chiefly affected since activities were replaced with new activities. The structure of communication was affected because it became possible for sellers to obtain instant feedback from customers over the phone during the product registration process. The actors affected by the changes were mainly the sellers in Alpha. Because of changes in the work process the sellers were required to change their behaviour. Furthermore, the change in technology required the sellers to acquire new skills.

Step 3: Effectiveness in product registration and visual representation of products

To improve effectiveness in the sales process, managers and other employees involved in sub-project 3 emphasised the need to *simplify product registration and visual representation of products* (Change requirement 1).

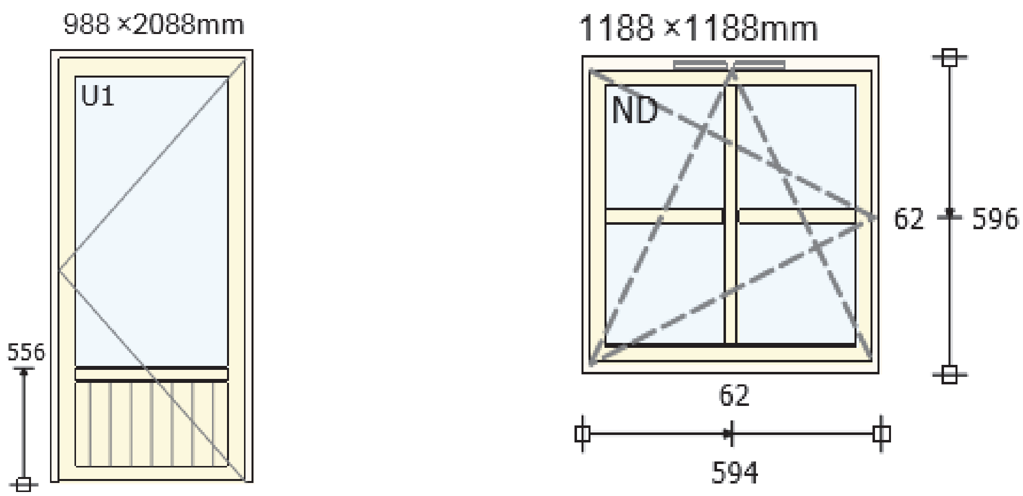


Figure 7.5 Product illustrations provided in the new sales module

Based on the sellers' experience of registering product specifications in the legacy system, they described the work process before SM as cumbersome. After SM, the sellers were enabled to register offers and orders on the screen in real time and they immediately saw if products were registered as intended. This was due to the rich details in the graphic product illustrations in SM as illustrated in Figure 7.5. These product illustrations are collected from an offer document.

Supported by SM, sellers registered the data correctly the first time and therefore only needed to register the data once. For this reason, the iterative activities such as controlling the offer specifications against print-outs and re-entering codes were no longer necessary.

Furthermore, increased effectiveness was achieved through more effective communication with customers. A sales manager in Alpha reported that in his sales department, communication between sellers and customers was improved, because the sellers were able to provide quick and accurate representation of a current offer or order. In contrast to the situation before SM, sellers were able to register a product, e-mailing a preliminary offer to the customer, and obtain immediate feedback while talking to the customer on the phone.

In addition, According to one sales manager, the number of mistakes committed after SM was noticeably reduced. Increased overview resulted in sellers making fewer mistakes and therefore, they also spent less time searching for errors and correcting them. Hence fewer mistakes resulted in reduced costs

Customers were able to increase effectiveness because they obtained offers more quickly and with more detailed and accurate specifications. Therefore, their ability to assess the offer according to the specifications of their needs was improved.

However, my results indicate that the potential for improvements may not have been exhausted. For example, more detailed and accurate graphic product illustrations were expected to make it easier for customers to understand the offer and order documentation they received from Alpha, which would allow them to detect deviance from their requirements earlier. However, one of the sellers reported that after the implementation of SM, the number of mistakes detected by customers remained unchanged. The reason for this may be that the communication was improved and that the customers saw it as superfluous to check the offer/order confirmation documents for possible mistakes.

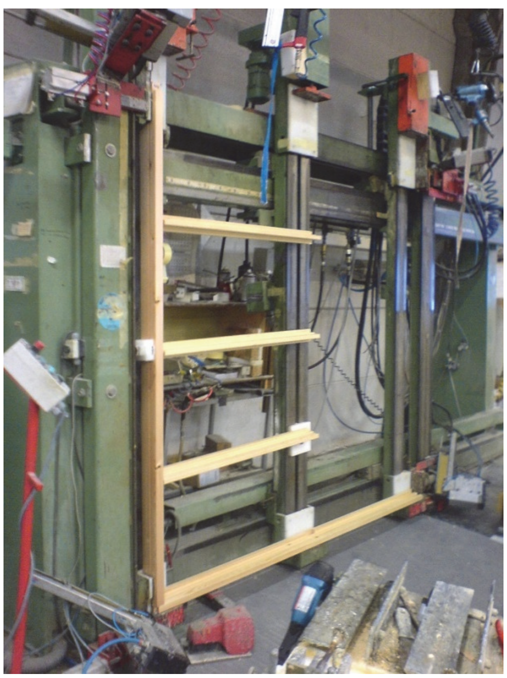
After a few months, SM was extended with a web-based offer/order registration module for customers. The first customers to use the module were big customers with knowledge and experience related to the Alpha products. Hence, the sellers handed over some of the product registration work to the customers, which was time-saving both for the customers and for the sellers.

To conclude, After SM, the sellers reported that quick and easy product registration and improved quality of product visualisation resulted in significant job simplification. Supported by SM, the product registration process undoubtedly became less cumbersome, less time-consuming and fewer mistakes were made, thus reducing costs (CSF 1.2). The data indicate some ambiguity about whether the new sales process supported customers to correct mistakes. Still, it seems quite unambiguous that the sales process after deploying SM was less error prone than before, because of improved quality in product registration, product representation and communication with customers.

7.2.2 Handling the sale of special-work products

In this section, I focus on the activities in the sales process related to handling the sale of special-work products, shortened to SpecWork.

Before SM, one of the main challenges, causing unnecessary labour and cost in Alpha, occurred when sellers sold products that exceeded the production constraints without realising the fact until the order was about to be produced. Such special-work products were referred to as "stowaway" products. As an example, a stowaway product could come into being if it exceeded the limits of the assembly machine (se Picture 7.1). If a product was too big or too small and thus beyond reach of this machine it had to be handled as a special-work product. However, if the sellers did not recognise it as special work and handled it as a regular product it became a stowaway in the production.



Picture 7.1 Assembly machine in Alpha

The errors that caused stowaway products to slip through the sales department unnoticed had serious consequences, and one seller explained that:

> *"Special-work orders are sometimes not detected before entering into production. These orders cause problems for production planners and sellers,*

> *and the production of undetected special-work orders causes significant losses for the company."*

Step 1: Modelling and describing the SpecWork process

To handle special-work products adequately in the sales process, managers had emphasised the need for a function that controlled whether product specifications were within production constraints or not. This control I refer to as the product specifications control, (ProSpeCo).

In Figure 7.6, I present process model extractions of the activities involved in SpecWork and ProSpeCo. The figure illustrates the activities performed by sellers in Alpha, related to Spec Work, before (B - left side) and after (A - right side) the deployment of SM.

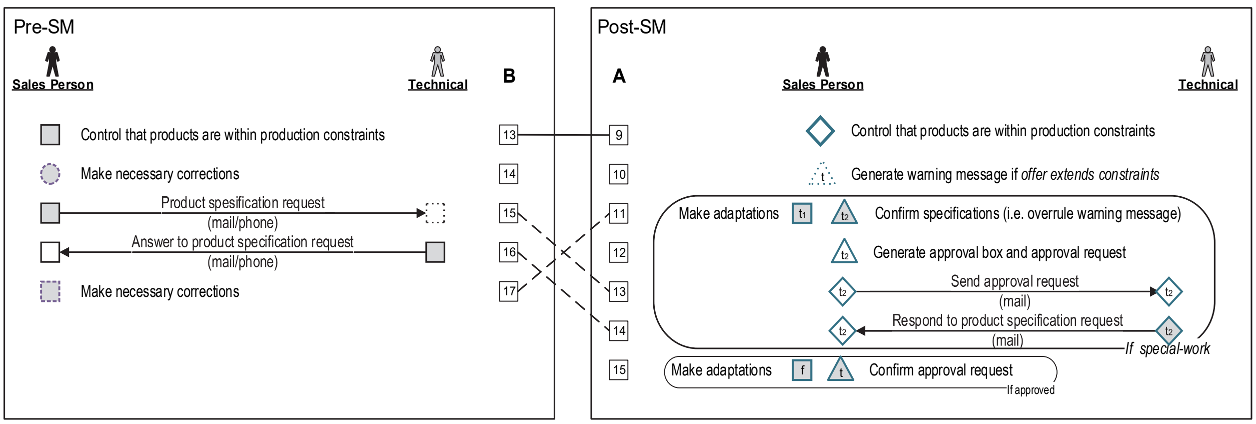


Figure 7.6 Process model illustrating changes related to the ProSpeCo control

Before SM, the sellers performed the control activities manually. They controlled that products were within production constraints by checking the product specifications specified by the customer against a list of constraints, as illustrated in activity 13 in the pre-SM process.

If specifications exceeded those constraints, the sales routine in Alpha was to make a product approval request to one of the experts in the technical department (activity 15). A specification request was then sent from the seller to the expert whose task was to assess whether specifications pertaining to a given product could be produced. The product development expert decided whether the seller was permitted to sell the product in question. If the product development experts decided to handle an offer as SpecWork, they calculated the costs of producing the product. The seller decided how to price the product based on the production costs, provided by the product development expert. If the product development expert rejected the specification request, adaptations had to be made by the seller and the customer.

After SM, the ProSpeCo control was automated: the SM system was programmed to control whether product specifications exceeded production constraints and to generate a warning message when such specifications were detected (activity 9 and 10).

The warning message was automatically generated and appeared on the screen as illustrated in Figure 7.7. The warning message is translated from Norwegian to English below the screenshot.

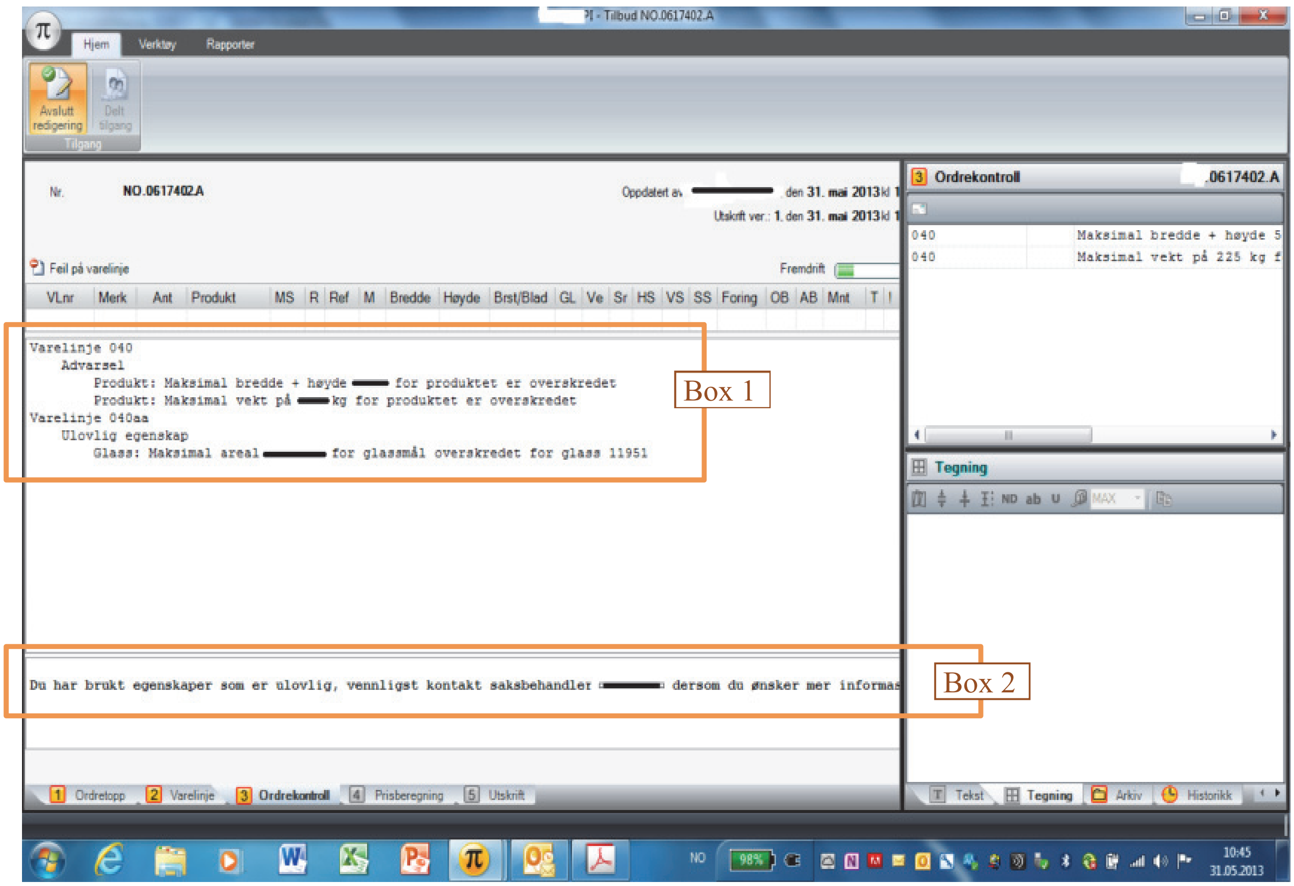


Figure 7.7 Illustration of a warning message

The warning message in box 1 says: Warning pertaining to product line 040: Maximum breadth + height X for the product is exceeded. Maximum weight of Y kg for the product is exceeded. The maximum area of Z for glass is exceeded. The text in box 2 says that you have applied values that are illegal. Please contact executive officer N.N. for additional information.

If a seller overruled a warning message and yet confirmed the special-work product, the SM system would automatically generate and send a product approval request to the technical department (activity 13). Thus, a product development expert decided to accept or reject special-work.

Step 2: Changes in the SpecWork process

After SM, the sellers handled the sale of special-work products differently. In this step, I compare and contrast how the sellers performed SpecWork at the two different points in time. Replacing the legacy system with SM resulted in modified, automated and new activities. These changes are further explained in this section and examples are provided.

Table 7.4 illustrate the changes that occurred after the deployment of SM. Below the table I identify, categorise and analyse these changes.

Table 7.4 List of changes in handling SpecWork

Changes in handling SpecWork
1. Activity 13 in the pre-SM process is replaced with the modified activity 9 in the post-SM process (control that products are within production constraints)
2. Activity 14 in the pre-SM process is made redundant (make necessary corrections)
3. Activity 10 in the post-SM process is new and automatic (generate warning message)
4. Activity 11 in the post-SM process is partially new (confirm specifications)
5. Activity 12 in the post-SM process is new and automatic (generate approval box and approval request)
6. Activity 12 in the post-SM process is new and automatic (send approval request)
7. Activity 15 in the post-SM process is partially new (confirm approval request)

Before SM, the ProSpeCo control was handled manually, and the sellers used product sheets, kept in binders, to look up the constraints pertaining to their sales. For example, the product sheets contained limit value parameters pertaining to product length, width and weight. Before SM, the performance of the ProSpeCo control relied on the judgement of the sellers. After SM, five out of seven activities in the ProSpeCo control were automated. Hence, the control activities were performed according to the predetermined norm represented in SM.

Before SM, sellers were expected to detect special-work themselves and, if necessary, send a product specification request to a product development expert. After SM, the system automatically warned the seller when special-work products were registered. Furthermore, after implementing SM, the structure of the decision-making authority was affected because the SM system automatically sent all special-work requests to the product development experts. Thus, the sellers were compelled to have the product development expert's approval before selling special-work products.

All four change variables were affected by the changes. The technology variable was affected because legacy technologies were replaced with SM. The task variable was chiefly affected since activities were replaced with modified or new activities. The structure of decision-making was affected, because a product development expert was automatically consulted in every offer/order containing SpecWork. The actors affected by the changes were the sellers and the product development expert. The sellers no longer needed to spend time doing activities such as manually controlling that products were within production constraints

Step 3: Effectiveness in SpecWork

To improve effectiveness in the sales process, managers and other employees involved in sub-project 3 emphasised the need to improve the handling of special-work products (Change requirement 2).

Among the main reasons for implementing the sales module was the production managers' dissatisfaction with the legacy system. They were dissatisfied with the legacy system because it allowed sellers to sell products that exceeded the production constraints without realising the fact until the order was about to be produced. The sellers and production workers referred to those products as stowaways.

Orders containing stowaway products caused problems because they could not be produced as planned and often caused production stoppage. Orders containing stowaways had to be taken out of the production line and re-planned. Thus, stowaway products caused huge delays and costs. According to one of the sales managers, the implementation of SM eliminated the "stowaway"-problem. He stated that in the period after the deployment of SM, he did not know of any "stowaway" incidents. Thus, the elimination of stowaways resulted in substantial cost reductions (CSF 2.3).

Furthermore, the sellers focused on selling as much as possible, but products exceeding production constraints were more expensive to produce than products in the production line. When sellers failed to recognise that a product exceeded production constraints, the price was often set too low. In contrast, with SM the product development experts considered both income and cost and calculated a higher price. Thus, when supported by SM, the sellers sold more products with higher profitability (CSF 2.2).

In addition, confirmed orders containing stowaways often affected the customers negatively in two major ways. Either the production was delayed, causing the customer to wait for their products, or the products could not be delivered and thus forcing the customer to find alternative solutions. These effects may have caused customer dissatisfaction. Eliminating the stowaway problem may have caused increased security of supply and thus increased customer satisfaction (CSF 4).

To conclude, the automation of the ProSpeCo control resulted in the elimination of stowaway products slipping through to the production unnoticed. This elimination has resulted in cost reduction and increased profitability and probably also increased customer satisfaction.

7.2.3 The offer follow-up process

In this section, I focus on changes in the follow-up process. The follow-up process comprises the sellers' activities after an offer is provided, see Figure 7.3 for an overview of the entire sales process. Mainly, the follow-up sub-process contains communication with customers to obtain information about the customer's decision-making process.

In the offer follow-up process, the seller's main purpose was to find out whether an offer could become an order. In most cases, this depended on the customers and whether they had won the tender. Typically, the seller asked questions regarding a tender, such as: "Has a decision been made?" "When is a decision expected to be made?" "Are there known postponements?"

If the customer had won the tender and entered into a contract, the seller investigated whether Alpha's offer had been used in the process to get the contract. If Alpha's offer was not used, sellers tried to find out whose offer was used, and, if possible, some details on the used offer were retrieved in order to find out why Alpha's offer had not been used.

When the customer did not win the tender, the seller would try to find out if a contract had been given, and if so, to which contractor. If Alpha had given offers to various contractors, competing for the same contract, the sellers would find out if one of those contractors had been given a contract.

Step 1: Modelling and describing the offer follow-up process

In Figure 7.8, I present the process model extract pertaining to the offer follow-up sub-process before and after the deployment of SM. Before SM, this sub-process was coordinated from the headquarters, and four roles were involved. When supported by SM, the offer follow-up sub-process was decentralised, and only two roles were involved in the sub-process. Further details are explained below the figure.

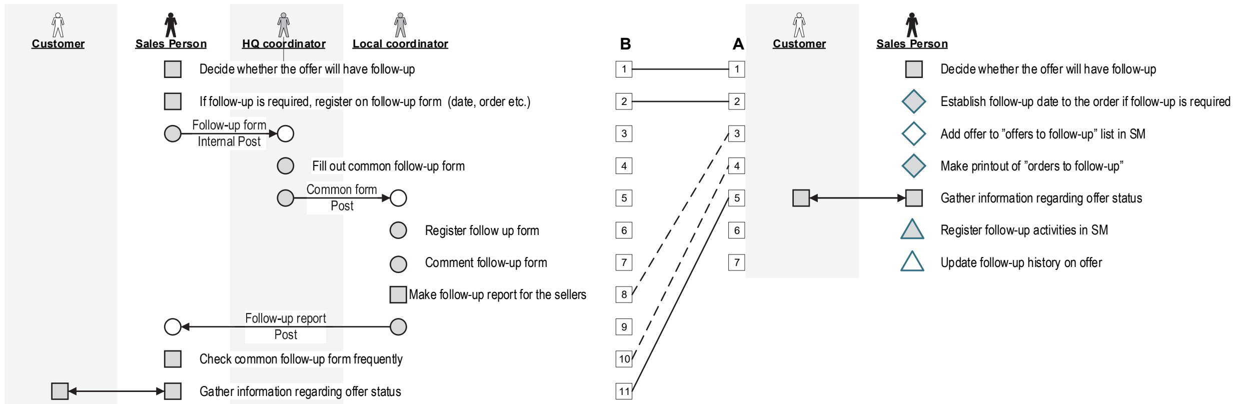


Figure 7.8 Process model illustrating changes in the offer follow-up sub-process

The offer follow-up sub-process started with a seller's decision to follow up or not to follow up on an offer. The sellers filled in a follow-up form and sent it to the sales coordinator. Thereafter, the sales coordinator collected and systematized the follow-up forms and prepared a common follow-up plan. The sales coordinator sent the follow-up plan to local sales representatives at each sales office. The sales representative (co-worker) registered, commented and made follow-up reports before they forwarded the plan to the sellers. Thereafter, sellers used the plan regularly to perform offer follow-up activities as scheduled. Typically, such activities implied asking questions regarding the customer's use of Alpha's offer in their process of attaining new contracts. The sellers returned follow-up forms on which they registered whether an offer was accepted, not accepted or cancelled.

In the offer follow-up process after SM, the process still started with a seller's decision to follow up or not to follow up an offer. If follow-up was required, the seller decided a date for follow-up and registered this date pertaining to the offer. When a follow-up date was entered, the offer was automatically added to a follow-up plan in SM. The follow-up plan generated could be filtered according to customer, salesperson, branch office or county.

Follow-up activities implied asking questions regarding the customers' use of Alpha's offer in their process of gaining new contracts. Thereafter, the seller registered the follow-up activities they performed, and they registered whether an offer was accepted, not accepted or cancelled.

Step 2: Changes in the offer follow-up process

Before SM, a sales coordinator working in the Alpha headquarters (HQ) unit made a common follow-up plan for all the sellers. After the deployment of SM, a follow-up plan was automatically generated in the system. Thus, the HQ sales coordinator role became superfluous. In the same way, the local coordinator role was made superfluous when the manual activities pertaining to the role were either automated or taken over by sellers in the new work process supported by SM. The sales system caused several changes in the follow-up process and these changes are listed in Table 7.5.

Table 7.5 List of changes pertaining to the offer follow-up process

Changes in the offer follow-up process
1. The HQ coordinator role was made redundant
2. The local coordinator role was made redundant
3. Activity 3 in the pre-SM process was made redundant
4. Activity 4 in the pre-SM process was made redundant
5. Activity 5 in the pre-SM process was made redundant
6. Activity 6 in the pre-SM process was made redundant
7. Activity 7 in the pre-SM process was made redundant
8. Activity 8 in the pre-SM process was replaced by activity 3 in the post SM process
9. Activity 9 in the pre-SM process was made redundant
10. Activity 10 in the pre-SM process was replaced by activity 4 in the post SM process
11. Activity 6 in the post-SM process was new
12. Activity 7 in the post-SM process was new and automatic

My analysis has revealed changes in all of Leavitt's (1965) four interdependent change variables: technology, structure, people and task.

The implementation of SM resulted in changes in the management structure. Before SM, the follow-up process was coordinated by a HQ sales coordinator but after SM, the coordination and management of the follow-up work process was built into the SM system.

As indicated in Figure 7.8, the roles of the HQ sales coordinator and the local coordinator role were made superfluous after SM.

SM replaced the manual handling of forms and plans, as illustrated in Figure 7.8. The notation (see Appendix III) in Figure 7.8 shows that the follow-up sub-process before SM was handled by manually filling in forms and plans and exchanging documents using the internal mail system. After SM, all sellers had access to the electronic follow-up plan in SM.

The task variable was affected because tasks were made redundant, modified or new. As an example, the SM system automatically generated an offer follow-up plan. This new functionality provided sellers with an always updated and accessible plan, and thus SM supported the sellers to perform offer follow-up activities according to the unified procedure.

The people variable was affected when the roles and tasks changed. In the offer follow-up process both the HQ sales coordinator role and the local coordinator role were made redundant. The employees who held these roles were given new responsibilities after SM. Furthermore, the modified and new tasks required people to acquire new skills. For example, the sellers were required to register data into the system and to do follow-up activities according to the plan automatically generated in SM.

Step 3: Effectiveness in the offer follow-up process

To improve effectiveness in the sales process, managers and other employees involved in sub-project 3, emphasised the need to digitalise the offer follow-up sub-process (Change requirement 3).

Among the main reasons for implementing the sales module was that managers needed to create a data base as a foundation for their analytic work. They anticipated a system that could improve their strategic decision making by anchoring the decisions to statistical facts.

Based on the data entered into SM, a follow-up history pertaining to each offer was generated. These data could be used by the sellers and managers in Alpha to analyse the offers, for example, which offers are more likely to generate orders and revenues? Reports based on the follow-up data registered by the sellers may result in better decisions and thus increased income in the future (CSF 1.2, CSF 2.2, and CSF 3.1).

In addition, the data collected during the follw-up process enabled sellers to assess their own performance by comparing it, for example, to the average performance or their own performance in previous periods. In the same way, sales managers were able to assess the performance of their sales office.

My analysis shows that the implementation of SM caused the HQ sales coordinator role and the local coordinator role to be redundant in the new follow-up sub-process. Hence, time was saved and if the time saved was spent effectively, for example, if more offers were conducted and these offers resulted in orders, the income may have increased.

Furthermore, one seller said that before SM, the follow-up activities used to be postponed to the day before they had to return the form to the sales coordinator. Furthermore, he stated that "ideally, it is best to do follow-up when you are already talking to the customer. According to this seller, SM made it easy to find relevant data quickly and helped the sellers to incorporate their follow-up questions in situations where they were already talking to the customer. Thus, SM caused the sellers' to save time both for themselves and for their customers and possibly additional cost reduction and increased customer satisfaction was achieved (CSF 4).

To conclude, SM enabled the managers to obtain data for management support in terms of, for example, which sellers and sales offices that turned most offers into orders. Furthermore, tasks and roles that were made redundant resulted in released time to perform new tasks and responsibilities. Thus, effectiveness was increased in relation to the offer follow-up process (CSF 1.2 and CSF 3.1).

7.3 Analysing effects from centralising the production-planning process

So far, this chapter has focused on how the managers in Alpha aimed to increase the effectiveness of the sales process. In this section, I focus on the managers' efforts to increase the effectiveness of the production-planning process. The managers' goal was to improve supply chain management by implementing a totally integrated ERP system.

I analyse changes in the activities related to production planning. I compare and contrast the local production-planning process conducted before PM2 with the centralised production-planning process enabled by PM2, and I discuss if and how effectiveness was affected.

In the analysis, I focus on three change requirements that Alpha's managers and other employees involved in sub-project 4 emphasised as necessary to successfully implement a production-planning module. The change requirements (CR) were:

- ✓ CR 1: Establish a totally integrated ERP system
- ✓ CR 2: Establish corporate production planning to replace local production planning
- ✓ CR 3: Implement delivery dates to replace delivery weeks

Step 1: Modelling and describing production planning

In Figure 7.9, I present models of the production planning processes before and after PM2. Both before and after the implementation of PM2, the production planning process started during the sales process.

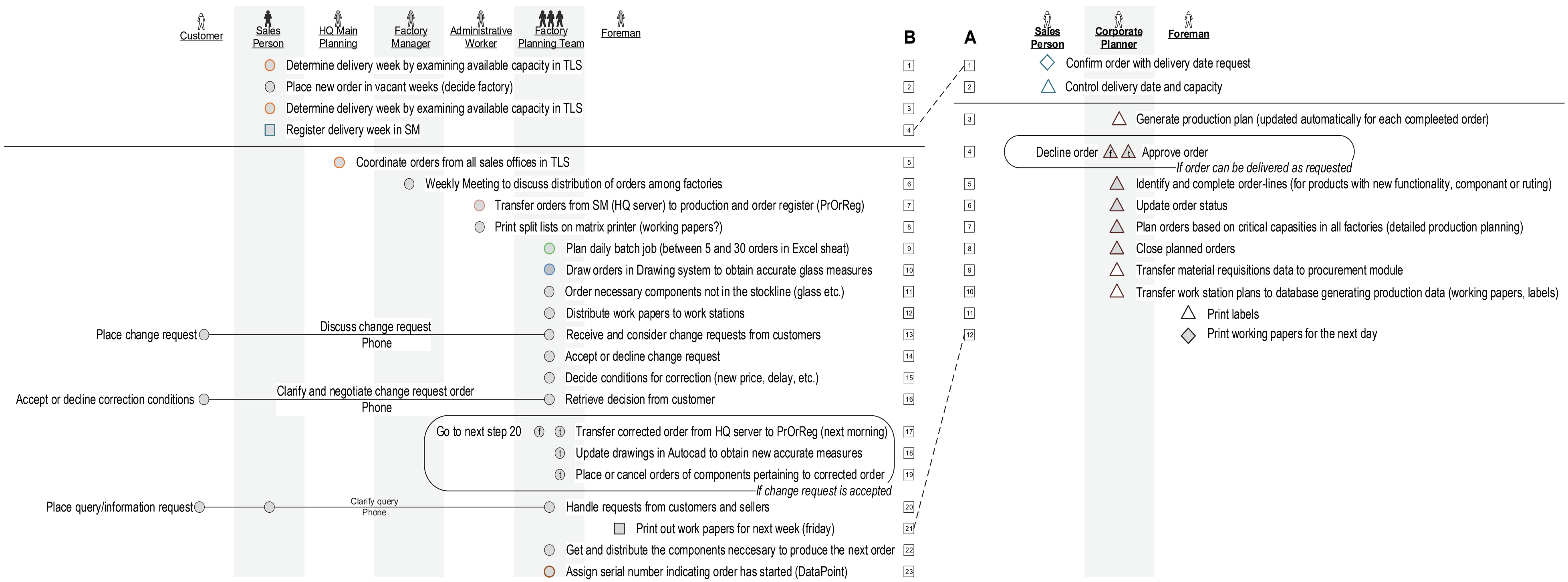


Figure 7.9 Process model illustrating changes in the production planning process

In Figure 7.9, a solid line is drawn where the sellers' responsibilities end and the production planners take over. Below the figure, I describe how the production planning processes were performed at the two different points in time.

Before PM2, production planning was conducted in the factories. After PM2, the production-planning process was centralised and conducted at the corporate level.

Before PM2, activities such as planning and procurement were conducted in weekly cycles. Regarding production planning, sellers determined the delivery week by first examining available capacity in all factories in a so-called "traffic light" system developed in Excel. In this system, the capacity for each factory was displayed, and each week was marked by a colour code. Red indicated that the capacity constraints were met for that particular week. Yellow signified that the remaining capacity was reserved for contract customers. The contract customers were large customers who had entered into a framework agreement that gave them priority to production capacities. Green meant free capacity available for all customers. The sellers placed new orders in vacant weeks in the "traffic light" system and registered delivery week in the pre-SM order system.

Thereafter, the orders were planned in detail at the local factories. Assessments regarding what and how much to produce each day of the next week was conducted in each factory. The planning included ordering the components necessary to produce the incoming orders.

Before PM2, the planners had to search for the components necessary to produce the next orders. Some planners spent most of their day searching for product components in the warehouse. They had to secure that all necessary components were available before an order was put into production. If an order could not be completed because of the lack of necessary components, the planners would set the order on hold until the missing component(s) were provided.Supported by PM2, planning was conducted every day. The PM2 software generated and updated the production plan to exploit total capacities in Alpha. The corporate planners adapted the automatically generated plan to make more detailed plans for each factory according to the factory managers' special knowledge. When corporate planners moved order-lines during the detailed planning, the consequences were immediately updated.

Before PM2, the customers were sometimes involved in the production-planning process regarding change requests, as shown in Figure 7.9. If a customer needed to change an order after the planning and production process had started, they contacted the production planners directly to discuss their change requests. Supported by the totally integrated ERP system, the sellers had access to the corporate production plan and were able to handle the change requests from customers.

Step 2: Changes in the production-planning process

Figure 7.9 reveals that the total number of activities in the after process was heavily reduced, and that half of the activities in this new work process were automated. Furthermore, Figure 7.9 shows that 10 out of 12 activities were new, that the remaining two were modified, and that 21 out of 23 activities were made redundant in the after process. In addition, Figure 7.9 shows that the number of roles involved in the production-planning process was reduced from six to three. Hence, my analysis, based on the production-planning process model in Figure 7.9 demonstrates that the production-planning process was totally transformed after the implementation of the ERP system.

Related to the implementation of PM2, my analysis has revealed changes in all of Leavitt's (1965) four interdependent change variables: technology, structure, people and task.

Replacing local production planning in the factories with corporate production planning resulted in a comprehensive structural change. Before PM2, the production-planning process involved local planning at all the factories. Thus, the decentralised production-planning process implied that all the factories in Alpha made their own detailed production plans based on the resources and capacities available in the individual factories. The centralised production-planning process was enabled by PM2.

As indicated in Figure 7.9, the technology variable was affected because the production-planning process before PM2 required the use of five different systems. The totally integrated ERP system made these legacy systems redundant.

The task variable was affected. As explained above, all but two activities from the before-process became redundant in the after-process. Furthermore, all but two activities were new, and six out of totally 12 activities in the after-process were automated.

The people variable was affected because the roles involved in the production-planning process were reduced from six to three. In particular, the local planning teams were made redundant because the detailed planning of local production was centralised and transferred to the corporate planning division at the Headquarter. Furthermore, the totally integrated ERP system showed how far into the planning and production process an order had come when customers' change requests arrived. Therefore, after PM2, such change requests were handled by the sellers, and thus customers were no longer involved in the production-planning process.

Step 3: Effectiveness in the production planning process and in Alpha

The corporate production plan replaced the decentralised production-planning process at the factory level (CR 1). The centralised corporate production plan increased the exploitation of the total capacities among factories (CSF 1.2).

The production-planning module (PM2) constituted the missing link to achieve the vision of a totally integrated ERP system to support the managers in supply chain management. By integrating the modules, data were entered into the system once and immediately accessible throughout the extended supply chain. Increased accessibility to updated data reduced administrative lead times. As explained in Chapter 2, a performance dip (Ross & Vitale, 2000) typically occurs just after deployment when the firm adjusts its processes and data to new circumstances. The performance dip in Alpha is documented in Figure 7.10. The four lines indicate weekly levels pertaining to the performance indicator *Security of supply* in four factories. The blue line belongs to the main factory. The performance dip in the main factory was deeper and lasted longer than in the three other factories. According to the corporate-planning manager, the production processes in the main factory were more complex than in the other factories. Thus, the adjustment of processes and data to the new environment was more comprehensive in the main factory. However, Figure 7.10 shows that in week 51, the performance indicator *Security of supply* was back on schedule.

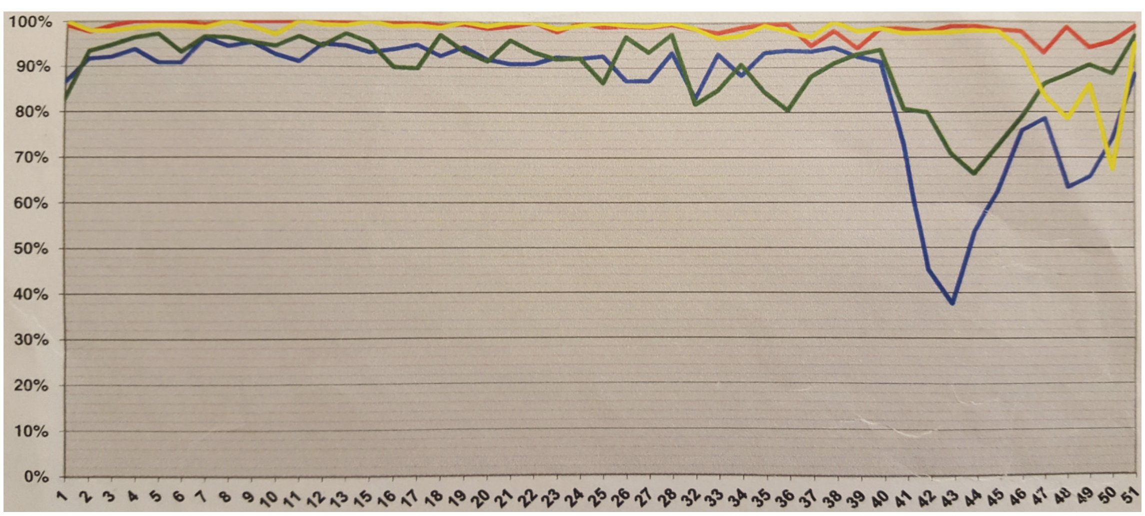


Figure 7.10 Performance dip in Alpha

According to the corporate-planning manager in Alpha, PM2 caused reduction of delivery times in all the factories. He explained that when order-lines in PM2 were planned (and closed), material requisition data were automatically transferred to the procurement module. Thereafter, procurement suggestions were automatically generated, and a procurement order was automatically sent to the supplier when approved by a purchaser. Thus, the integration among the modules enabled managers to improve supply chain management (CSF 1.2). Furthermore, the centralised corporate-production plan increased the optimal use of capacities among factories (CSF 1.2).

The reduced administrative lead times reduced the time products spent in production (CSF 1.2), in all factories. Before PM2, the delivery time was 20 days for all the factories. After PM2, the delivery time was between 13 and 20 days.

When the centralised corporate-planning division replaced the decentralised production planning at the factories, the local planning teams in the factories became superfluous. According to one of the top managers, corporate planning resulted in a workforce reduction of 13 full-time positions. This effect was realised through a combination of layoffs and not rehiring after retirements.

The sellers used the corporate-production plan to specify the exact delivery date of each order. Thus, the PM2 system enabled the sellers to accommodate the customers' requests to receive their orders on predetermined dates instead of a predetermined week (CR 2). This improvement made it possible for the customers to improve their building plans, and customer satisfaction was probably increased (CSF 4).

An additional effect of integrating the sales module, SM, and the production-planning module, PM2, was the access to data that made it possible for the top managers and the sellers to evaluate the profitability of products and customers. Thus, the ERP system enabled the top managers and the sellers to focus on profitable customers and products (G1, CSF 1.2, CSF 2.2 and CSF 3.1).

8 Discussion

In this chapter, I discuss how the top managers' involvement in the ERP system implementation project in Alpha may have affected organisational effectiveness. My discussion is organised as follows. First, I summarise the findings from the four sub-projects and the total project. Second, an in-depth discussion of how the managers handled the four sub-projets is provided. In particular, I discuss the differences in how the managers handled the sub-projects, and how these differences may have affected the outcome. This section includes the explanations of three successful ERP-system implementation sub-projects and one failure.

8.1 Summary of effects

8.1.1 Effects of sub-project 1

Sub-project 1 resulted in the successful implementation of accounting, warehouse management and procurement modules. The purpose was to establish "best practice" work processes supported by the ERP system modules, and the purpose was achieved.

After sub-project 1, managers reported that the accounting processes had substantially improved with the ERP system. Because of integrated and updated data, reporting had become easier, faster and more accurate. Furthermore, powerful functionality for generation of reports enabled new comprehensive reports to be generated and utilised to improve decision making related to supply chain management (CSF 1.2).

The managers reported that the ERP system modules significantly improved the effectiveness of the warehouse management and the procurement processes. Most evident was the 50 percent decrease in inventory costs, amounting to several million NOK (CSF 1.2). This reduction was possible because the ERP system provided an enhanced overview of inventory levels and purchase orders and the enterprise's needs for raw material and components.

After one year, the implementation had increased the efficiency of accounting and procurement processes as well, and had resulted in substantial cost reductions.

8.1.2 Effects from sub-project 2

The development effort had cost a lot of money, both for the ERP vendor and for Alpha in terms of human resources invested in the sub-project.

The implementation of a sale and production-planning module in sub-project 2 was a failure. In this sub-project the top managers entered into a fixed price contract with the vendor to develop a custom-made module to support the sale and planning of VBH products. After a heavy delay, the vendor delivered a solution. The delivery solved the problem of handling VBH products from a theoretical point of view, but when the solution was tested in a realistic production-planning setting, it turned out that it was not applicable. The module was not able to process a production plan and update changes fast enough to satisfy the production planners' needs.

The managers decided to attempt to improve the solution from the vendor with in-house staff, and they allocated resources and time to the project. The effort to improve the solution resulted in comprehensive and in-depth knowledge about current work processes and the perceived needs in the enterprise to improve the work processes, but the solution was not improved.

However, at one point, the project manager and the other members of the project team realised that even if they might be able to deploy the solution, some of the adaptations involved the programming of changes in the modules that would make it too slow to operate and difficult to maintain. Therefore, the present version of the module was not able to support the production-planning process according to their goals. The project managers informed the steering committee of their concerns, and the steering committee decided to put sub-project 2 on ice immediately, and soon after to discard the solution.

The effects of sub-project 2 were a substantial loss of investments for Alpha and the vendor. First, the investment in the fixed prise contract with the vendor was sunk cost. Second, internal resources allocated to sub-project 2 to improve the solution developed by the vendor resulted in additional losses for Alpha. Third, the solution was never implemented, and therefore the expected gains from the module were not obtained. Fourth, the vendor spent considerably more time and resources on the development of PM than estimated. Thus, substantial losses were inflicted on the vendor as well.

8.1.3 Effects of sub-project 3

The sellers in Alpha were dissatisfied with the current system because it did not enable them to specify orders completely or provide a graphic illustration of the products. Furthermore, the production managers were dissatisfied with the legacy system because it allowed sellers to sell products that exceeded the production constraints without realising the fact until the order was about to be produced.

Sellers and managers had clear ideas of how a new graphic sales module could be designed to resolve the challenges with the legacy system, accommodate their customers' needs and strengthen the competitive advantages of Alpha's products and services.

Because of the characteristics of the VBH products (made by measures), a custom-made sales module (SM) was designed and built. Customers had started to ask for electronic integration of shared processes. To satisfy the customers' demands for integration of shared processes, a web-based solution was provided and the biggest customers got access to the web-solution.

The implementation of SM was considered a success, because it had several effects that improved supply chain management(CSF 1.2). First, SM enabled the sellers to specify orders completely and provided accurate illustrations of products, all without manual handling. The illustrations included a detailed graphic presentation of all product varieties in addition to textual descriptions. The new registration process was less time-consuming and less error-prone, both of which improved effectiveness in the offer and order registration process.

Second, the handling of special-work products in the SM module was automated and prevented sellers and customers from entering orders in which the products exceeded production constraints. This feature contributed to the optimal explotation of capacities in each factory (CSF 2.3). Furthermore, the elimination of stowaway-products improved effectiveness because the sellers sold more products with higher profitability and fewer products with lower or negative profitability. In addition, eliminating the stowaway problem caused increased security of supply and thus probably increased customer satisfaction (CSF 4).

Third, the digitalisation of the offer follow-up process enabled managers to obtain valid data for management support in terms of which products and customers were more profitable (CSF 2.2. and CSF 3.1). Furthermore, the implementation of SM caused the HQ sales coordinator role and the local coordinator role to be redundant in the new work process.

In addition, the ability to filter data enabled sellers to assess their own performance by comparing it to their colleagues' performance, the average performance and their own performance in previous periods. In the same way, sales managers were able to assess the performance of their sales office.

Thus, the deployment and use of the SM module resulted in the opportunity to make better decisions and thereby to increase performance in the future, for both sellers and sales managers.

Fourth, the customers were able to generate their orders into the web-application themselves, and thus the integration of data was enhanced through the extension of the supply chain that included the customers (CSF 1.2). When customers started to register their own orders, this was time-saving both for the customers and for the sellers in Alpha.

Furthermore, the implementation of SM supported the improved work processes for sellers and customers, which resulted in numerous smaller improvements as analysed in Chapter 7. For example, the redundancy of matrix printers, copy paper, faxes and couriers when offer and order documents were automatically generated and attached to an e-mail, by SM. These changes resulted in fewer errors and delays, made it easier to make corrections, involved less manual handling and improved communication throughout the sales process. These changes contributed to time and cost reductions.

Finally, the SM module resulted in increased satisfaction among managers, sellers and customers, because the effects summarised in this section contributed to achieve their goal of increased profitability (G1, CSF 1.2).

8.1.4 Effects of sub-project 4

The implementation of corporate planning failed in sub-project 2, but succeded in sub-project 4. Before PM2, the decentralised production-planning caused sub-optimisation. The factory managers were not able to coordinate the planning work or optimise the use of resources and capacities. Instead, the local production-planning process implied that all the factories in Alpha made their own individual production plans, based on the resources and capacities available in the individual factories.

After sub-project 3, sellers and customers registered offers and orders into the sales module SM. By integrating SM and PM2, the data entered was accessible from the PM2 module, and utilised in the generation of a centralised corporate-production plan. Thus, the two modules and the integration between them enabled integrated planning and coordination at the enterprise level, and the integration of production across factories (CSF 1.2).

Furthermore, the centralised corporate production plan increased the optimal use of capacities among factories (CSF 1.2). The corporate production plan generated plans for all the factories and thus replaced the decentralised production-planning process at the factory level. As shown in my analysis in Chapter 7, the new work process caused the local planner role in the factories to be superfluous. According to one manager, corporate planning resulted in the workforce reductions of 13 full-time positions. This effect was realised through a combination of layoffs and not rehiring after retirements.

8.1.5 Effects of integrating the sub-project modules

The successful implementation of the corporate-planning module (PM2) constituted the missing link to achieve the vision of a totally integrated ERP system to support the managers in supply chain management. The effect of integrating the five modules was that the ERP system enabled managers to improve management of the extended supply chain (CSF 1.2).

With the linking of the modules, data could be integrated through the supply chain, meaning that when data were entered into the ERP system once, manual handling of data was no longer necessary. When data were entered into the system, they were immediately accessible to everyone throughout the extended supply chain. Increased accessibility to the data reduced administrative lead times (CSF 1.2).

The PM2 module was integrated with the ERP modules that pertained to accounting, procurement, warehouse management and sales, and this integration made it possible to access the corporate production plan from various parts of the supply chain. The corporate production plan was utilised in multiple work processes in the enterprise. For example, the sellers used the plan to specify the exact delivery date of each order. Factory managers used the plan to see when the pressure on capacities was going to be high, and when it was going to be low. The managers used this information further in the manpower planning process in the factories. For example, if the pressure on capacities was going to be high, the managers might make use of overtime to secure that the deliveries were completed as scheduled. Procurement and warehouse staff used the corporate production plan to decide what they needed to purchase, and what was leaving the warehouse.

With the complete order registration in the sales units, misunderstandings were not only reduced towards the customers, but the complete sales order data spread through the supply chain to the planning department and further to the procurement and the production departments. This functionality reduced the time products spent in production (CSF 1.2) in all of Alpha's factories. Before PM2, the delivery time was 20 days for all the factories. After PM2, the delivery time was between 13 and 20 days.

With the corporate production-planning module, not only did the managers have a tool to support optimal utilisation of all production resources across the factories (CSF 1.2), but the overview of the use of resources implied that the sellers could stipulate the exact delivery date of the orders. This feature provided increased service for customers as they were able to plan that the orders be delivered exactly when they needed them to be, according to their building plans (CSF 4).

Furthermore, the totally integrated ERP system gave the managers and sellers access to data that enabled them to evaluate which products and customers were most profitable (CSF 1.2, CSF 2.2 and CSF 3.1).

To conclude, the project organisation delivered the requested ERP system to the base organisation. The challenges related to sub-project 2 caused the delivery to be delayed. However, as indicated by the effects identified in my analysis, the implementation of the ERP system has contributed to increased profitability in Alpha, and thus increased organisational effectiveness.

8.2 Explanation of effects/results

In this section, I compare similarities and differences among the sub-projects in order to provide possible explanations for how the top managers' involvement in the projects may have affected the outcome of the sub-projects and the total project. I discuss how the top managers dealt with the demands of the stakeholders on whom the organisation was dependent, and how the top managers' involvement may have affected organisational effectiveness.

In Alpha, the owners were included in the top management group. Therefore, when I refer to the top management group that group includes the owners. By managers I mean the top management group, functional managers related to accounting, sales, production, etc., and the project managers. By employees I refer to those staff members who were affected by the ERP implementation, but were not managers. The customers are the contractors who buy or may potentially buy products and services from Alpha to use in their building projects. The suppliers are those who deliver or may potentially deliver goods and services to Alpha. This group includes the suppliers of semi-raw materials and other necessary components, such as planed timber, glass and aluminium articles. However, when referring to the suppliers of software systems, I use the term vendor.

8.2.1 The importance of visioning

To stay competitive in a market with increased competition from low-cost countries, the top managers and their key employees developed an ambitious vision of improving organisational effectiveness that exploited the potential of information and communication technology.

Furthermore, the top managers developed a strategy for realising the vision and preparing the employees for the change. In accordance with the business concept of being the leading producer of windows, the top managers saw the need for custom-made modules. They decided to apply standard ERP package modules when the modules represented "best practices" that could increase the effectiveness of their work processes in areas in which they did not have competitive advantages, such as accounting, procurement and warehouse management. In areas of their special knowledge, such as selling windows and producing VBH products, they decided to design the technology to fit their needs and strengthen Alpha's competitive advantage.

In my literature review, I referred to Finney and Corbett's (2007) frequency analysis of generic CSFs for ERP system implementation. According to the authors, visioning and planning are among the most cited CSFs in the literature. The vision and the strategy to realise the vision gave a clear direction for the management of the implementation project in Alpha

8.2.2 The importance of clear goals

The vision and the strategy for realising the vision were linked to a hierarchy of consistent goals. The paramount goal of the project was to increase the effectiveness of administrative and business processes and to integrate the business function areas to improve supply chain management.

Consistent with this overall project goal, the managers developed goals for each sub-project. These goals gave direction for each sub-project. The project managers and external consultants knew what they were expected to deliver to attain the overall project goal.

8.2.3 Support and commitment of managers

As mentioned above, the top managers took the initiative to the implementation project, developing the vision and formulating project goals.

During the implementation of the ERP system, the top managers were involved in the management of the project by organising the sub-projects, allocating resources and participating in the steering commitee. In addition, top managers, including the CEO, took part in open information meetings in the factories, where they informed the employees, answered questions and discussed expectations.

This active involvement from the top managers showed the employees that the ERP system implementation project was important. The employees understood the need for new computerised systems and the need to change processes to stay competitive. I did not detect any resistance to change during my visits to Alpha; on the contrary, the employees and the managers were committed to their common goals and looked forward to realising the vision. Some employees even expressed impatience during the longitudinal process of implementing the ERP system. According to Finney and Corbett (2007), top management commitment and support is the most cited CSF in the literature (see Chapter 2).

8.2.4 The importance of time, cost, quality and scope management

All projects, simple and complex, large and small, have constraints on what has become known as the golden triangle: cost, time and quality (Chen et al., 2009). In this discussion, I extend the golden triangle to include scope management.

In sub-project 1, the implementation of a standard ERP package consisting of three standard modules was managed by external consultants. The sub-project was conducted within time and budget, and the project scope was adequately managed. Furthermore, the built-in "best practice" work processes related to accounting, purchase and warehouse management, and the implementation of the system in Alpha, contributed to more effective work processes.

In contrast to sub-project 1, the implementation of sub-project 2 involved the development of a custom-made module named PM. The vendor developed the PM module. However, the delivery was delayed and the solution was unable to generate a corporate production plan fast enough to be usable in the actual corporate planning processes. When the top managers found out that the module was not applicable, the sub-project was not terminated. Instead, the top managers/the steering committee decided to attempt to improve the PM module, and they allocated resources to the sub-project.

In addition to attempting to make the solution provided by the vendor more usable, functional managers were allowed to request changes to the functionality of the ERP system. This feature caused an uncontrolled increase of the project scope. For an extended period, the ICT staff was programming additional functionality into the ERP system version that included the PM module, as requested by functional managers. Therefore, both time and cost limits were exceeded. Furthermore, the functionality added into the ERP system caused it to be increasingly intricate to handle and to maintain. As the ICT staff gradually understood this, they started to refer to the added functionality as "warts" in the system.

The losses related to lack of scope management in Alpha could have been avoided, if the steering committee had requested adequate assessment of the needs, before accepting the change requests. Furthermore, the steering committee should have required the project to assess if expected benefits would outweigh the expected negative consequences of the requested changes, such as cost increase or delays. Based on analyses provided by the project, the steering committee should have decided whether to consent to a change request. Regarding scope management, the steering committee's involvement in sub-project 2 was not in accordance with the guidelines for appropriate project management, as described in my conceptual framework in Chapter 3.

The scope increase in sub-project 2 caused the steering committee to realise the need for scope management in sub-projects 3 and 4. The members of the committee decided to limit the scope to include only what was necessary to achieve the goals of the enterprise, in order to secure that the software delivery was completed within time and budget. My thesis illustrates the importance of managing scope in order to manage time and costs. In Alpha, the top managers and project managers learned the importance of time, cost and scope management from the lack of such control related to sub-project 2. One of the technical project managers said: "The top managers have now realised that if they keep saying yes to all these things (requests for added functionality), then we will never achieve our goals."

8.2.5 Appropriate use of experts and vendor collaboration

The project teams in Alpha were composed with local specialists on the relevant work processes as well as technical experts. The sub-projects were staffed with experts to exploit competitive advantages in the development of more effective procedures with the support of new IT. The top managers allocated sufficient resources to the projects, but the number of local experts was limited, so there was a dilemma in allocating experts between the project organisation and the base organisation. Thus, the limited access to experts was one reason for the longitudinal implementation. Furthermore, the top managers decided that the project must not disrupt production. The CEO stated that the ERP implementation project was never prioritised at the sacrifice of daily operations.

Furthermore, implementation of an ERP system requires the assistance of technical consultants from the vendor. In sub-project 1, a linear waterfall approach was applied in the implementation of the accounting, procurement and warehouse management modules. This approach was very effective, because the goals and requirements were clear to the consultants who were experts on setting system parameters according to the requirements.

Based on the successful implementation of the three modules in sub-project 1, the division of work between the vendor and Alpha was continued in sub-project 2. The vendor entered into an innovation process, but was not able to develop the module that Alpha needed. The inappropriateness of the solution was not detected until after the module had been programmed.

As accounted for in Chapter 2, managers should pay particular attention to the early identification and correction of problems (Shehab et al., 2004). The programming of the PM module had to be done by external experts, but the lack of collaboration between the vendor and Alpha was inappropriate. The PM module was very complex with multiple integrations with several units, in addition to the comprehensive calculation function, optimising resource use. An iterative process involving end-users would have revealed the inappropriateness earlier.

I believe that the lack of cooperation between the vendor's consultants and Alpha's managers and employees during the development phase in sub-project 2 contributed to the failed development effort and the extent of losses in both enterprises.

The implementation effort in sub-project 2 became a learning experience that caused top managers and project managers in Alpha to approach the use of external experts differently in the remainder of the project. To reduce risk, the top managers and project managers decided to work more closely with the vendor's experts in the development and deployment of sub-projects 3 and 4.

My study illustrates that consultants from the vendor can be effective project managers in vanilla implementation projects intended to improve "best practices". In projects involving development of custom-made modules designed to strengthen competitive advantages, my study illustrates the necessity of a close collaboration between internal specialists on work processes and external experts on the software.

In Alpha's case, the top managers learned how to manage complex projects from experience. Some of the losses from sub-project 2 might have been avoided if the top managers had strengthened the project with a project management consultant.

8.2.6 The importance of human resource management

When a vendor had been selected and a contract signed, a project organisation with members from the ERP vendor and Alpha was established. The project was organised with a steering committee, a project manager and a project group. The members of the steering committee were the CEO and the technical director, who was in charge of the window production and window innovation efforts. The CEO of Alpha was the chairman of the steering committee and the project owner. He realised that he had the responsibility to allocate resources to the project throughout the project period.

The internal core members of the project group were three employees from the IT department with a thorough knowledge of the business and administration processes in Alpha. Additional members were appointed based on the competence needed in the various sub-projects, and the members were explicitly allocated time to devote to the project work. In addition, external members were appointed to the project from the vendor organisation.

The top managers' human resource management resulted in the establishment of a highly qualified project organisation in terms of knowledge about Alpha and ERP system software. The high competence might have contributed to the successful outcome of the ERP system implementation effort in Alpha as far as more effective work processes and efficient use of scarce production resources were concerned.

However, the competence in project management was low at the start of the project. According to the standard of project management presented in Chapter 3, the steering committee should have terminated sub-project 2 long before they did, because the project was repeatedly unable to provide deliveries as scheduled.

My study illustrates the importance of manning project organisations with members representing contextual knowledge, software expertise and knowledge on project management. The latter is corroborated by Robey, Coney and Sommer (2006, p. 568) claiming that the use of solid project management skills helps control a complex and risky ERP implementation process.

8.2.7 The necessity of dividing the project into sub-projects

As described above, the implementation of the ERP system in Alpha was divided into four sub-projects. Each sub-project was organised with clear technical interfaces among the modules that were related to each sub-project so that the modules could be integrated. This organisation of the project is in accordance with the advice by Chen et al. (2009), stating that "decoupling the large-scale software project, into flexible and manageable modules can be a challenge, and cross functional coordination is one of the most important issues in ERP implementations".

However, as my findings in Chapter 6 showed, a further important part of the management of ERP system implementation projects is to evaluate the characteristics of each sub-project critically to select an appropriate implementation strategy.

Table 8.1 provides an overview of similarities and differences among the sub-projects of the Alpha ERP system project. The categories for comparison are partly based on Wysocki's (2007) project characteristics and project management strategies that I have accounted for in my conceptual framework in Chapter 3. These categories are indicated in bold text. Partly, the categories have emerged from the use of the model in Figure 6.1 and the descriptions related to the model in Chapter 6. The table shows that there is a close relationship between the clarity of goals and requirements and solution, choice of implementation strategy and sub-project success.

Table 8.1 Comparison of similarities and differences among sub-projects

	ERP system modules: **Sub-project 1**	**Sub-project 2**	**Sub-project 3**	**Sub-project 4**
Sub-project characteristics:				
Goals	clear	clear	clear	clear
Requirements/Solution	clear	unclear	partially unclear	unclear
Complexity	low	very high	medium high	very high
Type of delivery:	standard, adapted	custom made	custom made	standard, heavily adapted
Top management support:	high	high	high	high
Internal competence of PO:	high	low	high	high
Composition of PO:	high	high	high	high
Recommended implementation strategy:	**linear**	**iterative**	**iterative**	**iterative**
Applied implementation strategies:				
Software development strategy	linear	linear	iterative	iterative
Work process development strategy	linear	linear	iterative	iterative
Deployment strategy	abrupt (small bang)	not relevant	incremental	incremental
Success or failure:	☺	☹	☺	☺

In sub-project 1, the goal and solution were clear. As recommended by Wysocki (2007), the managers chose a linear implementation strategy, and the sub-project was successful.

In sub-project 2, goals were clear, but the solution was unclear. This required an iterative implementation strategy according to Wysocki (2007). However, the linear approach from sub-project 1 was continued, and sub-project 2 failed. The project management strategy for sub-project 2 was inadequate. If intermediate solutions had been tested at Alpha during the programming stage, the failure of the solution would have been detected earlier.

After the failure of sub-project 2 the project team changed development strategies. In sub-project 3, the custom-made sales module was developed in an iterative process with the external consultants and the team members at Alpha. In sub-project 4 the heavy adaptation of standard software to represent corporate production planning data and procedures in Alpha were also developed in close collaboration between the Alpha members of the team and the consultants from the vendor.

To summarise, the managers in Alpha chose the appropriate implementation strategy in sub-projects 1, 3 and 4, and these sub-projects were succesful. In sub-project 2, the choice of an inappropriate implementation strategy was the main reason that the failure to deliver was not detected earlier.

Hence, my study supports the necessity to divide ERP implementation projects into more manageable sub-projects with clear technical interfaces among the modules so that the modules can be integrated. Furthermore, my study shows that it is important to evaluate the clarity of the goals and requirements of each sub-project and selecting an appropriate project management strategy for each sub-project (Wysocki, 2007). Thus, the table illustrates the importance of decomposing ERP projects into sub-projects and selecting the appropriate project management strategies for each sub-project.

8.2.8 The importance of risk management

During the initiation phase, the top managers made extensive preparations and plans to acquire the appropriate ERP system. At that time, the prevailing advice to managers was vanilla implementation, the implementation of an ERP system package with no or minimal customisation. However, the top managers in Alpha realised that their production of VBH-products required parts of the ERP system to be custom made to take care of competitive advantages. Development of modules to be integrated in an ERP system package, however, increased the risk of the project.

Risk analysis regarding the project and the project deliveries was not provided during the initiation phase, but after the failure of sub-project 2, the top managers and project managers effectuated measures to reduce the risk related to the remaining sub-projects and deliveries.

First, they decided to work closely with the external consultants. For example, regular meetings with the consultants were established to coordinate the efforts and to secure that the deliveries were going to meet the requirements.

Second, an iterative approach was applied in software and work process development, which implied that the in-house staff was heavily involved in the development of the software solutions. For example, extensive testing was conducted by internal project members, and they provided feedback to the vendor throughout the development process.

Both the close collaboration with the vendors and the iterative development and testing strategy reduced the uncertainty/risk related to the software deliveries.

Third, the top managers decided to adopt an incremental deployment strategy, as described in Chapter 6. In sub-project 3, the offer functionality was deployed prior to the order functionality. The experience gained from using the offer functionality reduced the uncertainty related to the quality of the order functionality and the deployment of this module.

In sub-project 4, the PM2 module was deployed in a pilot factory before it was deployed in the remaining factories. By deploying PM2 in the pilot factory first, it affected only a sub-set of the users, and in the case of failure, only the pilot factory would be affected. Therefore, experience gained from deploying and using the PM2 module in an actual production setting reduced the uncertainty/risk related to deployment and usefulness of the system in the remaining factories.

My findings show that top managers should ensure that the iterative development strategy is applied in development of software modules that involve some kind of customisation to reduce risk related to software development.

8.2.9 The importance of planning

I consider the work done in the Alpha enterprise in the chartering phase a major reason for the project's success.

The pre-project comprised the work with the vision and the communication of the vision to all employees. In addition, the job of standardising the names of the components involved in window production in all factories facilitated the implementation of the ERP warehouse management module. Furthermore, the careful preparation of the tender with a case illustrating the expected problems with the production-planning module did not prevent the failure of sub-project 2. However, the tender made it possible to enter into a contract with a fixed price.

The extensive work with the vision and preparation for tender guided the management of the project. However, the top managers did not take care that a formalised business case and project charter were developed to guide the management of the project during the planning and execution of project tasks. Furthermore, they did not ensure that the project applied approved methodologies for project management to handle the management processes and management areas described in Chapter 3. Consequently, the project managers did not appropriately apply project management tools, such as milestone and activity plans, responsibility charts, information and communication plans, risk analysis, etc. In addition, the top managers did not take care that a project charter was provided for the project managers to effectively manage the project between regular steering committee meetings. Prior to sub-project 4, a new project manager was hired. He developed a project plan in MS project to manage the progress of the sub-project. Thus, professional planning procedures for the development of the PM2 module were established.

8.2.10 The importance of effective communication

As described in Chapter 3, project managers should develop a communication plan (PMBOK®, 2008). Finney and Corbett (2007) support this recommendation as they list the factor "communication plan" as a generic CSF. However, having a communication plan is not the same as communicating effectively. Several authors mention “effective communication” as critical in implementation projects (see, e.g., Bhatti, 2005; Nah et al., 2001).

Even if the top managers in Alpha did not develop a communication plan the communication with the employees was effective, and the effective communication contributed to the successful project outcome:

The vision was communicated to all employees in several ways. The Alpha enterprise has short communication channels. The top managers are closely involved in the production and are regularly in contact with the employees on production and innovation matters. In addition, the top managers organised formal information meetings. For example, in the planning phase of sub-project 4, the CEO and the corporate-planning manager visited the factories. They prepared and informed all employees, and in particular, they focused on why this project was important and how it would affect the employees.

9 Conclusions

In this chapter, I summarise my main contributions and discuss their implications. Furthermore, limitations of this study are discussed and followed by suggestions for further research.

9.1 Contributions

In this thesis, I have investigated the implementation of an ERP system project that can be characterised as rather complex because the implementation involved two custom-made modules, a sales module and a corporate production-planning module. My findings show that the project deliveries were mainly according to the quality specifications, but that the scope in one of the sub-projects, sub-project 2, increased repeatedly and caused heavy delays and cost overruns to the main project.

Interviews with the top managers showed that the effects of the ERP system are in accordance with the managers' expectations. The effects were discussed in Chapter 8 in detail. The main effects were increased effectiveness of the extended supply chain, such as improved exploitation of capacities, reduction of costly mistakes (elimination of stowaways), and improved services to the customers. Furthermore, the ERP system led to a reduction of 14 positions, 13 positions related to production planning and one position related to sales coordination, which is a substantial cost reduction in administration personnel.

The analyses in Chapters 6, 7 and 8 showed that the top managers had an important influence on the effects: Top managers must be involved in ERP system implementations because an ERP system spans the whole organisation. Only the top manager has the authority to make decisions at the level above the units that will be influenced by the system. In Alpha, the top manager and his team took active parts in the implementation project as discussed in Chapter 8. The top managers communicated the vision effectively by explaining the future enterprise supported by an ERP system; they authorised necessary measures to prepare the enterprise for the ERP implementation, they manned the steering committee with top managers including the CEO, and they allocated necessary resources to the project and organised the sub-projects.

However, the analyses of the top managers' involvement also revealed their lack of project management knowledge, for example, related to scope management and the responsibilities of a steering committee. This lack of project management knowledge was a main reason for delays and cost overrun in sub-project 2.

A critique of the factors considered critical for successful implementation of ERP systems is that they are explained in vague terms (Elstad, 2014). My findings contribute to concretise and illustrate some of the generic CSFs at the top of Finney and Corbett's (2007) list, such as top management commitment, effective communication, effective composition of a project team, consultant selection & relationship and visioning & planning.

My thesis has contributed to the development of models and techniques helping researchers get an overview of a large quantity of data. I have extended the PSIC model by Lyytinen and Newman (2006, 2008) to fit my research question and thesis project. The extensions are presented in detail in Appendix II. The main extensions are that I have adapted and extended the vocabulary, included representation of sub-projects and extended the use of the model for analysis and explanation. Furthermore, I have extended the RIC technique (Iden, 2009)so that it is suitable for comparing processes and highlighting effects. The details of my extensions are presented in Appendix III. These extensions may also be useful to consultants and managers when they evaluate the effects of organisational change projects.

9.2 Implications

My findings have implications for managers. They show that managers need two types of consultants when they are implementing an ERP system project. Because of the technological complexity, managers need consultants from the vendor when they are implementing an ERP package, and they need other types of specialists, such as programmers, when the project involves the development of custom-made software. As discussed in Chapter 1, managers are often not trained to manage large projects. They do not fully understand the complexity, size, and risks involved in ERP implementation projects (Ferratt et al., 2006). In such cases, they need the support of a professional project manager to help them apply project management methodologies and appropriate project management tools, such as business case, project charter and process modelling techniques, to complete the project according to requirements, in time and on budget.

My findings have implications for the management of ERP system implementation projects. My study supports the importance of dividing a complex project into more manageable sub-projects (Chen et al., 2009). In addition, my study demonstrates that it is essential to evaluate the complexity of each sub-project critically and to select an adequate implementation strategy. However, this critical evaluation should not be limited to the technical complexity of each sub-project, but to the organisational complexity as well. The results from sub-projects 3 and 4 demonstrate how an iterative process change strategy can be successfully integrated with an iterative development of a custom-made module. In sub-project 3, the project risk in terms of time and user satisfaction was heavily reduced because experienced users were involved in the requirement specifications, design, testing and deployment of the module so that the organisational change process was an integrated part of the development of the new ERP system module. In sub-project 4, the risk was reduced because the corporate production-planning module was deployed incrementally. It was first deployed in one factory that represented all aspects of Alpha's window production.

9.3 Limitations

A limitation of my thesis is the degree to which the empirical findings regarding Alpha are valid for other organisations. Case studies have been criticised because of their inability to generalise their findings (Eisenhardt, 1989). Therefore, in Chapter 4 I have discussed the initiatives I carried out to strengthen the external validity of my research. However, the aim of this study was not to show universal findings that could apply to all ERP system implementations, but to produce context-specific knowledge that could be relevant outside this particular setting.

This limitation could have been alleviated by adding more enterprises that implemented an ERP system. A combination of different enterprises and ERP system implementations could have been used to broaden the perspective of my research. However, given the limited time and resources available, I considered that the use of data from one enterprise with four rather different sub-projects and two custom-made modules would be adequate for my purpose.

According to Cook and Campbell (1979), findings from case studies can to some extent be generalised or transferred to other settings if corroborated by other studies. Several of my findings are in line with other studies on ERP system implementation, particularly studies on generic CSFs as mentioned above (top management commitment, effective communication, effective composition of a project team, consultant selection & relationship and visioning & planning). Umble, Haft and Umble (2003) made a list of reasons for failure. They placed "Top management is not committed to the system" and "Implementation project management is poor" as reasons number 2 and 3. They placed "Strategic goals are not clearly defined" as reason number 1 – which is consistent with my emphasis on development of a vision. Furthermore, studies by Chen et al. (2009), Mandal and Gunasekaran (2003) and Clemons (1998) corroborates my findings regarding the importance of breaking ERP project into sub-projects.

Another limitation of my study is that only sub-projects 3 and 4 were studied in real time. Sub-project 1 was studied in retrospect. Effects from the implementation of the three standard modules were reported in general terms except for the 50 percent decrease in inventory costs.

Thus, effects from sub-project 1 are probably underreported. Sub-project 2 was studied partly in retrospect, but with rich data on the problems encountered.

As mentioned in Chapter 8, I did not detect resistance to change. Thus, a limitation of my study is that it does not include top managers' handling of resistance to change. The employees understood the need for the changes.

9.4 Further research

The purpose of this thesis was to enhance the understanding of how the top managers' involvement in an ERP system implementation project influences organisational effectiveness. In Alpha, the top management team had a technical understanding of the potential of integrated software to improve the effectiveness of their value chain. Thus, in Alpha, the top managers developed the vision and realised the potential of an ERP system to improve the management of the entire supply chain. Future research could investigate top managers' involvement in the project organisation and management of a complex project in cases in which the strategic managers do not have a technical understanding of integrated software.

Another line of research building on my thesis could be to focus on the co-operation among the business managers, local specialists and experts on agile project management and evaluate effects on the golden triangle in cases that involve the development of custom-made modules.

As discussed in the literature review and my conceptual framework, principles of project management and particularly agile project management are not properly integrated in the literature on ERP system implementations. One reason may be that most of the empirical articles on ERP system implementations only involve an ERP system package. One of the contributions of my research is the demonstration of the necessity of agile project management in ERP system implementations involving custom-made modules. The development of standard interfaces has facilitated the integration of modules from different vendors and custom-made software. There is a need for more studies investigating the implementation of ERP system solutions that exploit this technological development in order to create competitive advantages.

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Appendices

Appendix I

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Appendix I – Interview guides

Interview guide for CSF interviews (Rockart, 1979; Fuglseth, 1989)

1) Introduction

Present myself, explain the study and the purpose of the study (a framework for measuring the effects of implementing an ERP system in Alpha), explain how the interview is structured and its purpose and agenda, and explain that the respondent will be able to revise the answers in a later feedback interview. Explain the purpose of tape recording, transcription of interviews and confidentiality.

2) How would you describe your job, current role(s) and Alpha?

Keywords: title, unit, period of employment, job responsibilities, tasks, leader and closest co-workers

3) Discussion of goals and strategy: What are the goals and strategy of Alpha? What are the goals pertaining to the implementation of the ERP system in Alpha?

Keywords: formal and informal goals, organisational and unit goals, superior and subordinate goals, operational and non-operational goals

4) Elicit Critical Success factors

Keywords: Explain concept, Post-It method. For each goal: Which factors do you perceive as critical to obtain this goal, and what is the priority order of the factors? Measurable and non-measurable factors, operational and non-operational factors

5) The way forward

The interview will be transcribed and analysed in the context of all the CSF interviews. A framework for measuring the effects of implementing an ERP system in Alpha will be drafted. In our next meeting, the framework will be discussed and revised with the managers, first individually and thereafter together in a joint feedback meeting.

Interview guide for CSF feedback meeting

Introduction: Explain the purpose and the agenda of the feedback meeting. Present the analysis and discuss the findings

Keywords: unclear goals and CSFs, unclear relationships between goals and CSFs. Discuss if factors mentioned by different managers can be merged (same content) etc.

Appendix II – The adapted and extended PSIC model[1]

The PSIC model by Lyytinen and Newman

Lyytinen and Newman (Lyytinen & Newman, 2006, 2008) have developed a model to describe and explain processes related to implementation of information systems (IS). They illustrate their model using data from a case study reporting the development of a claims processing system in an insurance company over an eight year period.

The view underlying the model is that introduction of new information technology (IT) components inevitably change work processes. The model has been developed for IS projects that are characterised as complex and dynamic with a high degree of uncertainty as regards outcomes. Furthermore, the model recognises that mapping and analysis of IS change require involvement of several organisational levels. The authors have handled the challenge of mapping the change processes, including the interactions among levels, by developing a model that gives a graphical overview of a long-term implementation process.

The model is called a Punctuated Socio-technical Information system Change model – PSIC, indicating the theoretical background. In the following I briefly explain these theories and the model before I explain my extensions of the model in the next section. For an extensive presentation and explanation of the model, see Lyytinen and Newman (2008, 2006).

The authors posit that IS change can be viewed as alternations between longer periods of incremental adaptation and briefer periods of revolutionary, episodic change (Lyytinen & Newman, 2008, p. 593). The episodic changes are termed punctuated after Gersick (1991). According to the authors (2008, p. 593), IS change is primarily episodic.

The authors have adopted Leavitt's (Leavitt) socio-technical (S-T) theory to characterise the content and drivers of IS change. The theory views organisations and organisational subsystems as multivariate systems of four interacting and aligned components: task, structure, actor and technology as illustrated in Figure II.1. The theory distinguishes between two system states: stability and instability. When a system

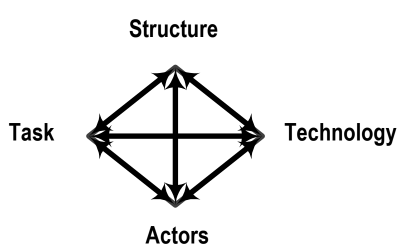

Figure II. 1 Leavitt's diamond

[1] Based on Buverud, Fuglseth and Grønhaug (2010)

has stable relationships within and between the system's components and its environment, it can respond adequately in relation to its task. When the four components are not aligned, the performance will deteriorate. Misalignments can be caused by events in the environment, such as a financial crisis, but it can also be due to managerial interventions, such as IS changes.

IS change is a deliberate change in (part of) an organisation. It is a planned change with the purpose to create new or re-configure work processes in order to increase effectiveness using new information technology. In the model, the authors distinguish between the work system and the building system. The work system is the part of the organisation that is influenced by the new technology. The building system is a separate system that has been explicitly erected to plan and carry out the changes. An elegant feature of the PSIC model is that the authors use Leavitt's theory to represent changes both in the work system and in the building system.

The building and the work system are embedded in broader systems that are termed the organisational context (the inner context) and the environmental context (the outer context) (Pettigrew, 1990). The organisational context includes the authority and resources, culture and the political systems in which the IS change takes place. The environmental context includes the social, economic, political, regulatory and competitive environment in which the organisation operates.

Figure II.2 gives an overview of the PSIC model illustrated with some of the data from my study. The multi-level characteristic of IS change is represented in five rows. Events in the environmental context, in the organisational context and in the building system are described in text boxes in rows 1, 2 and 3 respectively. Rows 4 and 5 show the effects of the events in the building and work systems presented on S-T form (S-T diamonds). Misalignments in the work and building systems are presented as double-headed thick arrows between components of the S-T model. A misalignment is called a "gap". For example, a computerised system that is not able to calculate employees' wages correctly, results in a misalignment between task and technology, that is, a task-technology gap.

IS change is described as a sequence of S-T diamonds. Interactions between the work and the building systems are represented by arrows between rows 4 and 5. The type of arrows between the diamonds indicates the nature of the event. A dotted arrow (e.g., between B1 and B2) indicates that the event has resulted in incremental changes. A solid arrow (e.g., between W1 and W2) indicates that the event has resulted in a punctuated change. Developments in the gaps between S-T diamonds indicate whether the outcome has been a success or failure. If the gap persists, see, for example B3 and B4, or the number of gaps among components increases, the action has been a failure, or problems are increasing. If the gap has disappeared (see, W1 and W2), the action has been successful.

The box "Antecedent conditions" to the left indicates that researchers must collect data to place the IS change in a historical context. They must understand the organisation's current situation and the necessary conditions that have triggered the IS change. The box to the right termed "Outcomes" describes the results of the IS change process.

In Lyytinen and Newman (2006) the graphical overview has been complemented with tables describing events, actions and misalignments in the building and work systems in detail.

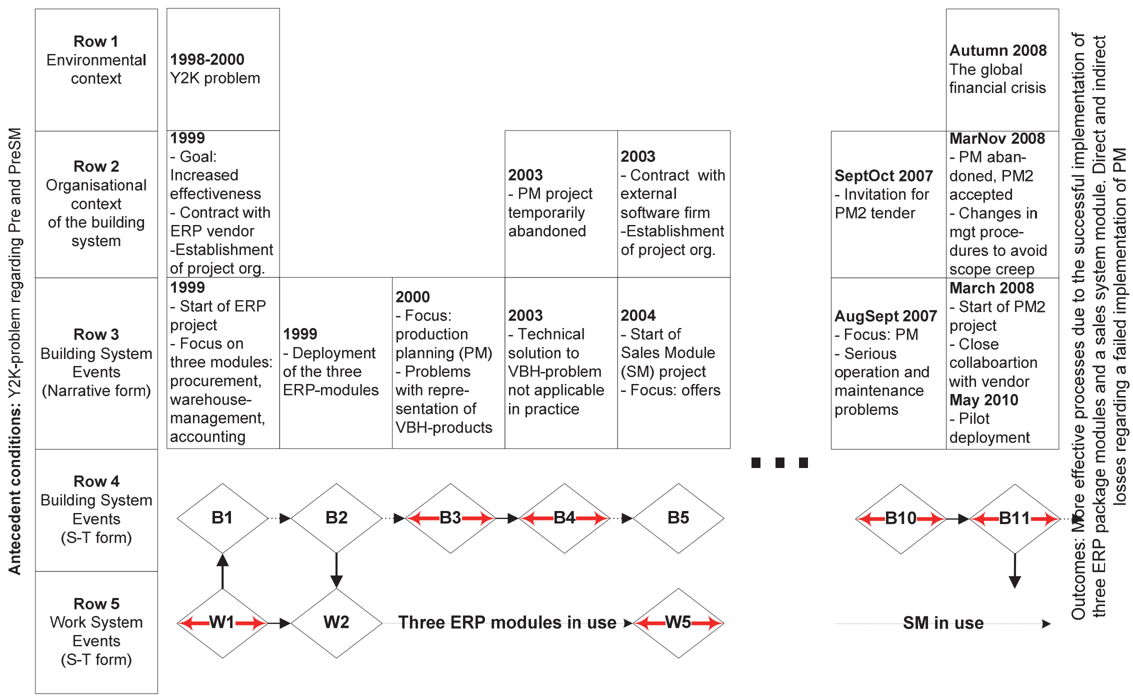

Figure II. 2 The PSIC model

The PSIC model thus gives an overview of a longitudinal development and implementation project on a graphical form. The model presents IS change as a sequence of events related to the building and work systems and the interactions between the two systems – that are embedded in environmental and organisational contexts. The model takes into consideration that IS change may involve both successes and failures, and that changes can be both incremental and revolutionary.

Extensions and adaptations of the PSIC model

The PSIC model is based on assumptions that are relevant also for this thesis. I, therefore, adopted the PSIC model to guide the description and analysis of my data. However, in my study of the implementation and use of an ERP system, I had a need to adapt and extend the model. This need is related to the purpose of my research and the characteristics of the ERP implementation project that I have studied. I have applied the adapted and extended PSIC model in Chapter 6 of this thesis.

The purpose of my research is to enhance the understanding of ERP implementation projects so that managers can handle such projects effectively. My research is thus closely related to project management and managers'/leaders' roles in ERP projects. Therefore, I adapted the vocabulary of the PSIC model so that it reflects project management explicitly, that is, I have replaced the terms building system and work system with project organisation and base organisation. These are terms that are usually applied in the project management literature (see, e.g., Kolltvedt et al., 2009).

In order to emphasise managers' and other decision-makers' roles in the projects, I introduced a distinction between events and actions in line with, for example, Langley (1999). In this study an event is something that happens in the external environment or in the base organisation outside the managers' control. An action means doing something as the result of a deliberate decision (choice). Events are indicated with normal text, while actions are shown in italics.

As noted above, ERP projects are characterised by a technology composed of several modules that interact. ERP projects may consist of several sub-projects that are related to the development and implementation of one or a few modules. An example of a sub-project is the implementation of an accounting module. Another example is the implementation of a production-planning module. In the description and analysis of my data I need to distinguish between the sub-projects and emphasise which tasks that are in focus in specific periods. Therefore, I extended the presentation of the S-T diamonds in the PSIC model as shown in Figure 6.1 in Chapter 6.

Each sub-project is presented with an S-T diamond in a specific colour. To enhance the legibility when printed in grey scale, sub-projects are also named in abbreviated form. The diamonds are shown partly overlapping, and the sub-project that the project managers are currently giving priority, is presented in the foreground in bold lines. Other sub-projects are indicated in dashed lines. The name of the sub-project is usually related to the relevant ERP-module, and the name of the sub-project in the foreground is shown by an abbreviation. For example, the abbreviation SM in Figure 6.1 in Chapter 6 indicates that the sub-project is handling the implementation of the Sales Module.

In order to keep track of the successes or failures of sub-projects, I needed to include the outcomes of each sub-project. Therefore, I added a row 6 to show intermediate outcomes. Outcomes may be related both to the base and to the project organisation. For example, if the project group responsible for a part delivery is not able to handle the task, the outcome will be presented as a failure related to the project organisation. Successes and failures are shown by symbols of happy and unhappy faces.

I believe that visually keeping track of relationships between events, actions and outcomes of sub-projects makes it easier to detect patterns in and among sub-projects. Detection of patterns – similarities and differences among sub-projects – may again enhance the understanding of how to manage sub-projects with certain characteristics effectively.

Figure 6.1 in Chapter 6 summarises my extensions and adaptations of the PSIC model to my research purpose and ERP project characteristics. The symbols that are used to show gaps and the consequences of events and actions are the same as the symbols in the PSIC model. In my model, however, I have another definition of the term "gap". In the PSIC model a gap is defined as "any situation in the system, if left unattended, that will deteriorate the system's performance, or threaten its long-term survivability" (Lyytinen & Newman, 2008). In line with the assumptions of my research that managers'/leaders' goal is to increase organisational effectiveness, I have defined a gap in the S-T diamonds also to represent a potential, that is, situations where the managers see opportunities for improvement. Problem gaps are shown with dark grey arrows, and opportunity gaps with light grey arrows.

Strengths and limitations of the adapted and extended model

In this section I evaluate the strengths and limitations of my model by comparing it with the original PSIC model by Lyytinen and Newman (2008, 2006) and from the experiences of applying the model in Chapter 6 on the implementation of an ERP system in Alpha.

Adaptations and extensions of vocabulary

Adapting the vocabulary of the model to reflect concepts from the project management literature may seem merely a cosmetic change, but it signals clearly a relevant theoretical perspective that may guide the analysis and explanations of ERP implementation projects as shown in Chapter 6.

The extension of the vocabulary with the distinction between events and actions I see as a clear advantage. The distinction emphasises the relationships between events and the actions in the project organisation to handle the events. Thus, the distinction helps to draw attention to *how* the project organisation solved problems during the project period. Furthermore, the distinction also draws the attention to the top managers' involvement in the ERP implementation. In Figure 6.1 in Chapter 6 the actions in row 2 are primarily related to the top managers' decisions and activities.

The redefinition of the "gap" term is also important in relation to my research purpose. A gap in my model does not necessarily indicate a problem. It can also indicate an opportunity to increase organisational effectiveness. The distinction between these two types of "gap" highlights whether the managers have a focus on exploiting the opportunities of ERP technologies to create new services.

Representation of multiple sub-projects

The extension of rows 4 and 5 in my model to represent sub-projects is also a clear advantage when analysing complex projects that can be decomposed, such as the project in Alpha.

Presentation of the sub-projects in different layers helps the researchers maintain the overview of the main project and follow the progress of each sub-project. This is not possible in the original PSIC model, see Figure II.2. Figure 6.1 in Chapter 6 presents the ERP system implementation process in Alpha and thus illustrates the model characteristics. The focus between sub-projects changes, particularly with colours to distinguish among the sub-projects, makes it is rather easy to follow the shifts of focus among the project tasks.

In the original PSIC model intermediary outcomes of a sub-project are not included, see Figure II.2. The extension of my model with row 6 – the success/failure of sub-projects – facilitates the understanding of interdependencies among sub-projects or between part deliveries within one sub-project. In Figure 6.1 (in Chapter 6) such interdependencies are illustrated in sub-project 3, see the gap in BO7. Furthermore, row 6 helps to signal the relationships between project characteristics, the implementation strategy and results, see, for example, sub-project 3 – the development and implementation of the SM module – that clearly shows the conscious selection of an incremental strategy. In most sub-projects, however, the description of the relationships between projects characteristics, explicit or implicit choice of implementation strategies and results have to be complemented with text, as shown in Chapter 6.

Use of the model for analysis and explanation

I believe that the model is primarily useful to support researchers in the analysis and explanation of ERP implementation process studies.

In this study I have found the model useful at two levels: It was useful to get a consistent overview of critical events and actions that may explain outcomes, and it created a visual structure for describing the process in detail. I also found the model useful for communicating my analysis and explanations to other researchers. Furthermore, I found it useful in meetings with the top managers and key employees to validate the analysis and explanations of project outcomes in Alpha.

At a more general level, the model may be useful to communicate the results of ERP implementation process studies to other managers and to research communities. For example, the theory-based explanations that were generated in Chapter 8 may be of interest to other managers. Table 8.1 illustrates the importance of decomposing ERP projects into sub-projects and selecting appropriate project management strategies for each sub-project. The table shows that there is a close relationship between the clarity of goals and requirements and solution, choice of implementation strategy and result.

The original PSCI model was developed to support the explanation of processes related to the implementation of a claims processing system, and the model is adequate for that purpose. My model has been extended to support the explanation of processes related to the implementation of an ERP system. My extensions are influenced by my research needs. A characteristic of the Alpha enterprise is the focus on one sub-project at a time due to limited resources. Due to sequential attention to sub-projects I found that the layered presentation of the S-T diamonds improved the overview of my data. In other projects there may be a need to extend the model to include presentation of several parallel sub-projects. A possible solution might be to make the S-T diamonds smaller and place them beside each other. An alternative might be to introduce one row per sub-project.

Thus, the model should be applied in other ERP process studies and extended further according to the researchers' needs. Applying the PSIC structure in several process studies, facilitating the comparison of similarities and differences among the studies, may enhance the understanding of *how* to manage ERP implementation projects effectively. Furthermore, application of the PSIC structure for process studies is not limited to projects involving information systems, but might be useful to describe and explain complex organisational change projects in general.

Appendix III – An adapted and extended modelling technique

To illustrate and describe the work processes in Alpha and how they changed, I have used a process modelling technique named RIC (Iden, 2009). However, to accommodate my needs in this study I have adapted and extended the RIC modelling technique.

For the purpose of this thesis, I needed to compare and contrast work process models and to illustrate how the business processes changed because of the ERP system implementation in Alpha. I have applied the technique in Chapter 7 to illustrate and describe changes in the sales process and the corporate planning process.

Business process modelling

According to Aguilar-Saven's (2004) classification framework, role interaction diagrams (RIDs) are appropriate for the purpose of describing work processes that involve coordination of activities among multiple roles. Aguilar-Saven (2004) states that "due to their notation and ability to break down activities, very complex processes can be displayed" (Aguilar-Saven, 2004). I needed a detailed representation of complex work processes that involved coordination of activities among multiple roles. Therefore, I decided to apply a role interaction diagram.

In RID, activities are presented vertically, and the roles are shown horizontally at the top (Aguilar-Saven, 2004). Thus, the process model constitutes a matrix in which text and symbols are used together to represent the process. Each activity is related to a performer so that the responsibilities are defined (Aguilar-Saven, 2004). The layout of the models is developed and read from top to bottom. Each role has its own column, and each row will contain one (or more) activity/activities. Activities follow vertically in chronological order. The horizontal dimension represents responsibility and interaction.

Aguilar-Saven (2004) argues that RIDs are intuitive to understand and easy to read, but they tend to be messy with many arrows pointing left and right. However, the RIC modelling technique differs from the RID diagram with regard to the use of arrows to illustrate activities. In RIC, activities are illustrated with boxes (arrows are applied to illustrate hand-over activities between roles). Thus, the "messy arrows" are removed in RIC.

The RIC modelling technique

Roles In Cooperation (RIC) is a type of role interaction diagram (RID) developed by Iden (2009). I selected the RIC technique to model work processes in Alpha because it was intuitive and easy to read. I intended to use this technique to model work processes before and after the deployment of the sales module and the production-planning module.

Iden (2009) describes the RIC modelling technique as consisting of symbols for role, activity, collaboration, hand-over, choice and iteration, as shown in Figure III.1 and described below.

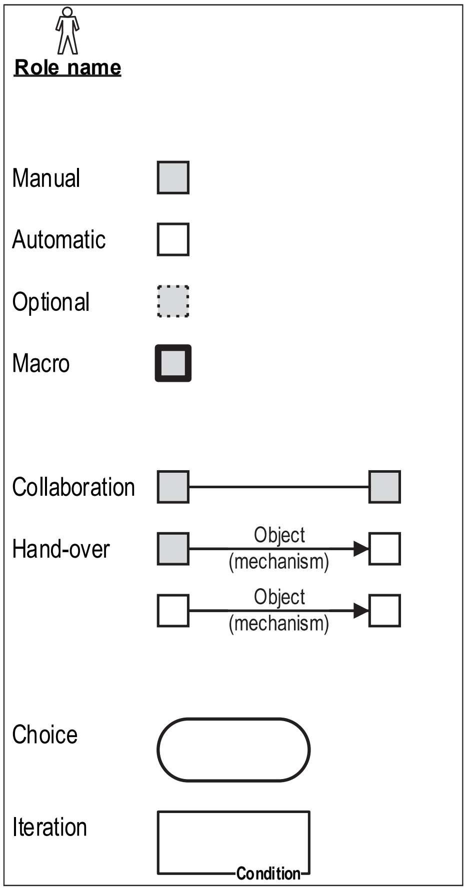

Figure III. 1 RIC notation

A role is represented by naming the role at the top of the column.

Four types of activities are represented by different types of square boxes:

- *Manual activity:* Solid grey box with a solid black line.
- *Automatic activity:* Solid white box with a solid black line.
- *Optional activity:* Solid grey box with a dotted black line.
- *Macro activity:* Solid grey box with a solid black bold line.

In addition to the square box, each activity is followed by a text description. The text describes the activity by using verbs in the imperative form.

Collaboration between roles is represented with a line between activity-boxes.

Hand-over from one role to another is represented by an arrow from a manual or automatic activity (sender) to an automatic activity (receiver). Above the arrow is a description of what is delivered, and below is a description of the mechanism used for the delivery.

Choice among alternatives is indicated with an oval box surrounding the alternatives. Iterations are indicated by a surrounding rectangular box. The condition for the iteration is noted on the box.

In Figure III.2, I have provided an example to illustrate the RIC modelling technique. The process model is illustrated with data from a sales process in Alpha.

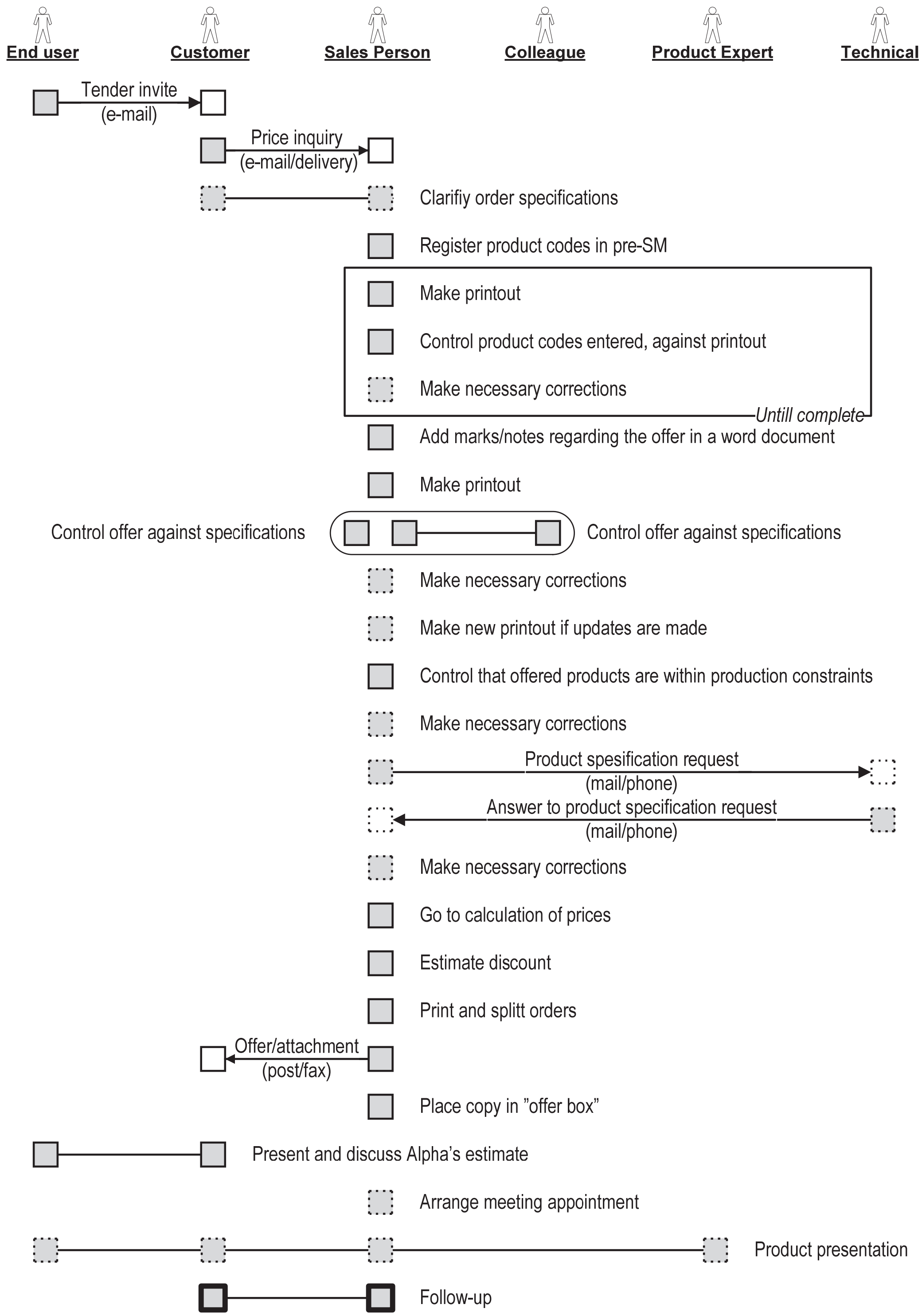

Figure III. 2 Illustration of the RIC modelling technique

Adaptations and extensions

In this study, I first applied the RIC-modelling technique to model the sales process in Alpha. However, I realised that the technique was not adequate to represent the sales process accurately. Therefore, I needed to adapt and extend the RIC technique as presented below:

Role

According to RIC, a role is represented in the model by a role name (position title, birth name, group title, department, etc.) and a person symbol at the top of each column. A role may be a person or a group of persons.

I needed to distinguish between external and internal roles to emphasise decision makers' possibility to influence the roles and activities. Internal roles are directly influenced by the managers' decisions. External roles are likely to be less influenced by the managers in Alpha. Thus, the distinction between internal and external roles may help managers to decide which roles and activities to focus on to become more effective.

In my extension, internal and external roles are indicated with the placement and the colouring of the role symbol. The person symbol that indicates external roles is not coloured, and it is placed on the left side at the top of the process model. The person symbol that indicates internal roles is shown with a solid light grey colour, and placed on the right side, as illustrated in Figure III.3. The role name is indicated under each symbol.

I have also included a third type of role, called the *perspective role.* In my study, processes were modelled based on interviews with key informants. The perspective role represents the viewpoint from which a process is modelled. Therefore, when a perspective role is present, it indicates that the work process modelled is based on the viewpoint of this (these) particular role owner(s). For example, data regarding the sales process were mainly gathered from interviews with sellers. Other roles involved in the sales process were not interviewed. A perspective role is shown with a solid dark grey colour of the role symbol, as illustrated in Figure III.3.

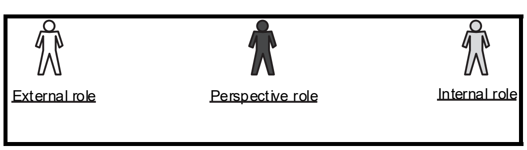

Figure III. 3 Notation for roles in a work process

Activities

I needed to extend the notation of activities for my purposes. In this effort, I borrow from Jackson Structured Programming (JSP) (Jackson, 1975). In JSP there are three basic structures, they are: sequence, selection and iteration. I have adapted and extended the modelling technique to include all three basic structures.

A sequence is a structure that "has two or more parts, occurring once each, in order" (Jackson, 1975, p. 17). A sequence may contain selections and iterations, I will revert to these structures below.

In the RIC modelling technique activities are presented vertically. Thus, the vertical dimension represents the chronological order and the sequence. I adopted and applied the vertical sequential order of activities.

In RIC, there are four types of activities: manual, automatic, optional and macro (Iden, 2009). According to Iden (2009), an "optional" activity means that the role holder may decide whether it is necessary to carry out the activity or not. In Alpha, I encountered activities that were either mandatory or conditional. The term "optional" was not adequate to describe the activities that were not mandatory. Therefore, by replacing "optional" activities with "conditional" activities, I have adapted the technique to reflect my need. In this study, a conditional activity implied that in a given situation employees were expected to assess or examine whether a condition, or set of conditions, was met or not. Based on their assessment, they were expected to perform their tasks according to established procedures. For example, if the order value exceeded NOK X, two sellers were required to control the offer against the customers' specifications. If the order value did not exceed NOK X, only one seller was required to perform this particular control activity.

Iden (2009) does not consider that activities could, for example, be both manual and optional. Furthermore, "collaboration" and "hand-over" were applied, but not defined as activities. The activities involved in this study were performed either by one performer as independent work or in collaboration with other performers. Accordingly, I have divided the activities into two main categories: individual and interaction activities. Both individual and interaction activities were either mandatory or conditional. Both mandatory and conditional activities could be either manual or automatic. Finally, manual and automatic interaction activities could be either a hand-over or a collaboration activity. Thus, I have structured activities into a hierarchy of four levels for individual activities and five levels for interaction activities. In other words, there are twelve different types of activities as shown in Table III.1.

Activity											
Individual				Interaction							
Mandatory		Conditional		Mandatory				Conditional			
Manual	Automatic	Manual	Automatic	Manual		Automatic		Manual		Automatic	
				HO*	C**	HO*	C**	HO*	C**	HO*	C**

***HO=Hand-over, **C=Collaboration**

Table III. 1 Hierarchy of activity attributes

Individual activities

By individual activities, I mean activities that are performed by one performer. Furthermore, individual activities are either mandatory or conditional. Individual-mandatory and individual-conditional activities are further divided into two sub-categories: manual and automatic. The notations for individual activities are illustrated in Figure III.4.

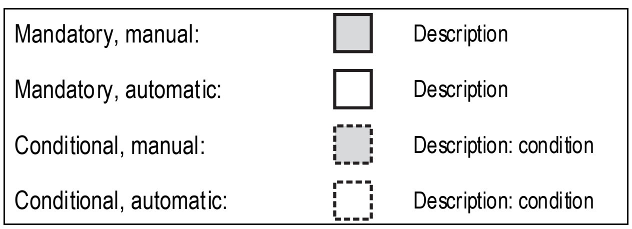

Figure III. 4 Notation for individual activities

Each activity is illustrated with a square box with a solid drawn line for mandatory activities and a stippled line for conditional activities. The boxes representing manual activities are coloured with a light grey colour, and automatic activities are not coloured. Iden (2009) suggests using verbs in imperative to describe the activity, and this I find useful. Therefore, a description of each activity is indicated to the right of each box. For conditional activities, both a general description and the condition for the activity is indicated.

Interaction activities

By interaction activities I mean activities that include two or more performers. Similarly to individual activities, interaction activities are divided into mandatory and conditional activities, and interaction-mandatory and interaction-conditional activities are further categorised as either manual or automatic. In addition, interaction activities are further divided into the categories known as collaboration and hand-over activities.

Both collaboration and hand-over are described by Iden (2009), and with some minor adaptions, I have adopted the RIC notation for both "collaboration" and "hand-over".

As described above, the individual activities are modelled with square boxes. However, adding a line between two or more activity boxes indicates collaboration among actors to perform an activity. I have added a text to describe the collaboration activity and the means of collaboration. I have described the collaboration activity above the line and the arena of collaboration below the line, as illustrated in Figure III.5 and exemplified in Figure III.6.

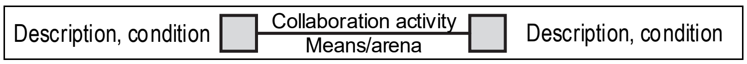

Figure III. 5 Notation for collaboration activities

For example, the collaboration activity could be a discussion and the means of collaboration could be a meeting. The roles may have different responsibilities in the meeting as illustrated in Figure III.6.

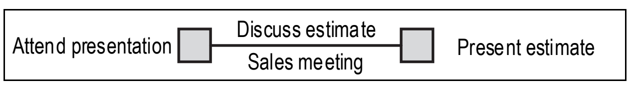

Figure III. 6 Example of collaboration activity

To illustrate hand-over activities I have adopted the notation from the original RIC modelling technique in which an arrow represents hand-over from one role to another. Furthermore, a description of what is delivered above the arrow and a description of how it is delivered below the arrow. However, I have extended the notation to include a description and or a condition indicated in the same row, next to the boxes, as illustrated in Figure III.7.

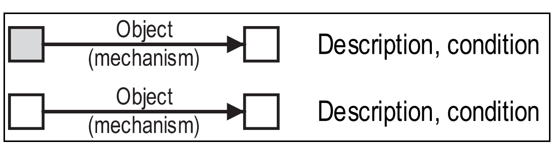

Figure III. 7 Notation for hand-over activities

Selection

In the interviews, employees described work processes that required them to make decisions based on an assessment of conditions, as mentioned above. The RIC modelling technique applies a notation for Choice (Iden, 2009). However, choice was not adequate to describe the work processes in my study. The choices the employees made in Alpha resulted from an evaluation of alternatives, that is, the decisions they made were conditional. Therefore, in my process models I needed to portray the alternatives and conditions involved in decision making.

To represent the work processes more accurately and in accordance with my research needs, I have replaced the notation for Choice with the s*election structure* from JSP (Jackson, 1975).

According to Jackson (1975, p. 27) "a selection has two or more parts, of which one, and only one, occurs once for each occurrence of the selection component". Hence, a selection implies a choice/decision between alternative activities based on a condition. The selection condition determines which activity (or activities) the role owners should choose. The notation for a selection is an oval box surrounding the alternatives, and the selection condition is indicated in the bottom right corner of the box, as shown in Figure III.8.

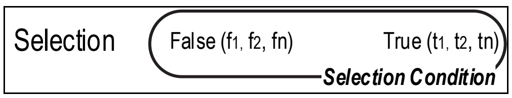

Figure III. 8 Notation regarding selection

The selection condition is either true or false. The activity or activities that are initiated if the selection condition is true are indicated with a "t" (true) in the activity-box. In the same way, the activity or activities that are chosen if the selection condition is false are indicated with an "f" (false). Determining the selection condition to be either true or false may require one or more conditional activities. If several activities are required they are numbered as shown in Figure III.8.

Iteration

According to Jackson (1975, p. 20), "an iteration has one part, which occurs zero or more times for each occurrence of the iteration component itself". Thus, the iteration structure implies a sub-sequence of activities/steps that are performed repetitively until the iteration condition occurs. In my interviews, I used the term "repetition" to explain iteration.

In my process models, I have adopted the notation used in the RIC modelling technique in which iterations are indicated with a rectangular box surrounding the sub-sequence involved in the iteration, as illustrated in Figure III.9.

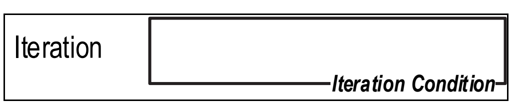

Figure III. 9 Notation regarding iterations

The iteration condition is indicated in the bottom right corner of the box and determines if a role owner should carry on repeating the action or continue with the next activity in the main sequence that follows below the iteration box.

Sub-process

During the modelling of business processes in Alpha, I modelled sub-processes as part of the overall process, and I needed to be able to refer to a sub-process in my models without modelling all the details of the sub-process. By sub-process, I mean logically related activities that are part of the overall business process. As explained in the beginning of this appendix, a sequence consists of an action, or event, that leads to the next ordered action in a predetermined order (Jackson, 1975). Iden (2007) describes a *Macro* as "a complex activity that can be detailed into several separate activities". Thus, sub-process, sequence and macro explain similar phenomena. However, in my research, a sub-process was not necessarily complex. Furthermore, in my communication with Alpha employees I used the term sub-process because it was a known term. Consequently, I have replaced the term "macro" with the term "sub-process".

To model a *Sub-process*, I have applied the notation used to model a *Macro*, with some additions. A solid grey box with a solid black bold line indicates a sub-process. A sub-process could involve one or more performers (i.e., collaboration), and if so, a line between the boxes indicates the performers' collaboration in the sub-process. In addition, a description of the sub-process is provided in the same row as the box or boxes, as illustrated in Figure III.10.

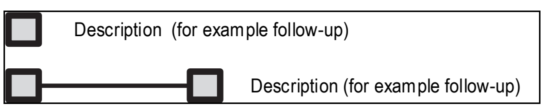

Figure III. 10 Notation for sub-process

System support

In this study, I needed to distinguish between activities that were supported by an IT system and activities that were not. When an IT system was used to perform an activity, the system use was indicated with a coloured line around the activity box. Each system was indicated by its own colour, as shown in Figure III.11 and in Figure III.12.

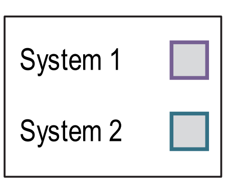

Figure III. 11 Notation for system support

Illustration

In the RIC model, a short text describes the activities pertaining to each row. I found it necessary to complement the models with richer textual descriptions to provide a deeper understanding of the activities and the process. Therefore, I have described the entire processes in detail, with references to the numbered activities in each sub-process. These models are enclosed in Appendix IV.

Figure III.12 gives an overview of the adaptations and extensions of the RIC modelling technique, illustrated with data from the offer registration process in Alpha before the implementation of an ERP module.

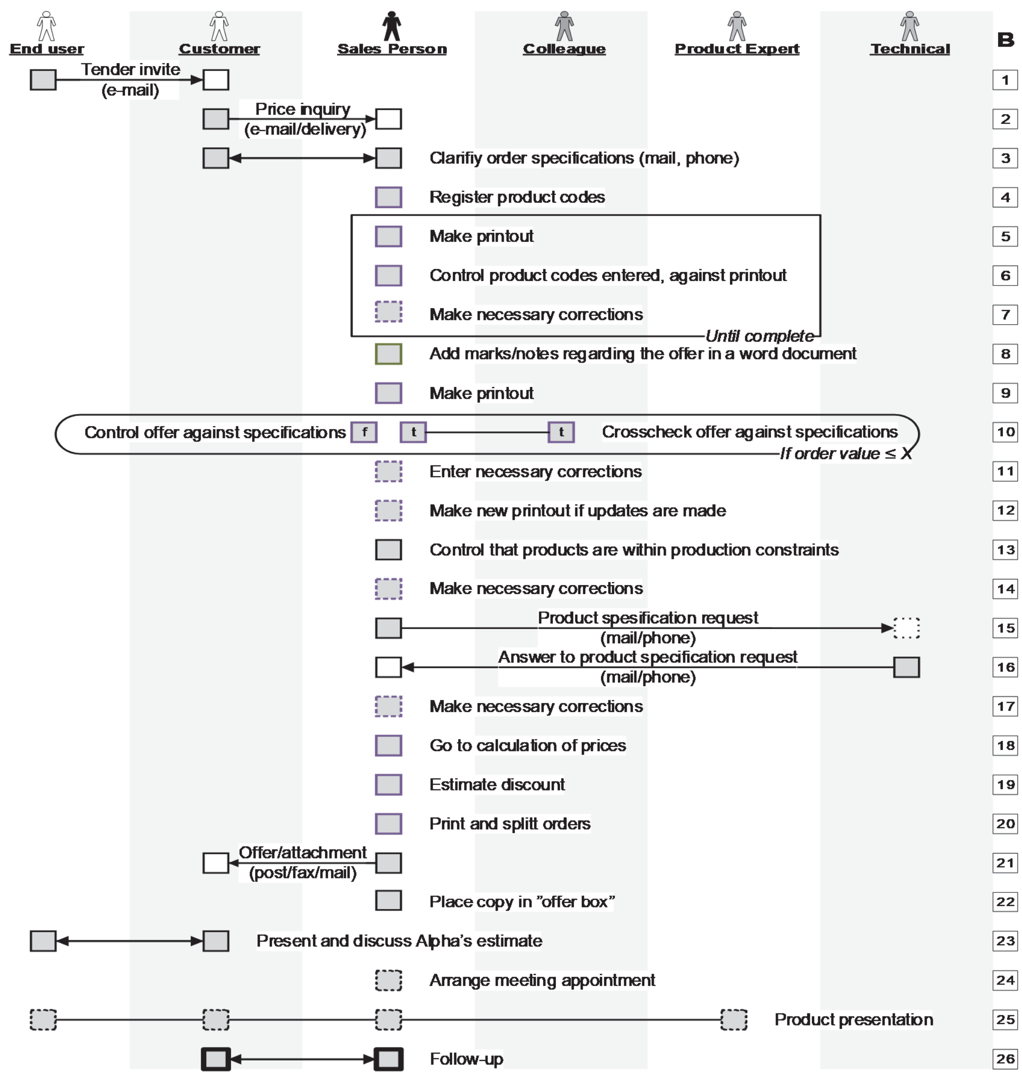

Figure III. 12 Illustration with data from this study

1. This process starts with a tender invite from the end user, in which one or more of Alpha's customers is invited. In this case end users are the customers of Alpha customers.
2. Based on technical requirements provided in the tender invite, the customers place a price inquiry to Alpha.
3. Often clarifications regarding offer specifications are required. This clarification requires communication between customer and seller. For example, if a customer is building a school, that may require a particular type of glass according to current building regulations.
4. Product codes are registered in the pre-SM system, which is a code-based system. When a seller enters product codes into the system a list of codes representing window specifications are shown in the user interface on the screen.
5. When new codes are entered a printout is made from a matrix printer with flimsy paper.
6. A control of the window specification codes entered is performed. A printout is necessary to control that entered codes are correct. The printout provides illustrations of products specified in the offer. This illustration will only appear on printouts and not on the screen. A control of the codes entered is performed by comparing product drawings on the printout against code specifications from the customer (gathered in activity three). For example, when windows are placed in close vicinity sellers control the alignment of the window bars.
7. When discrepancies between sellers' intended specifications and product drawings on printout are discovered, necessary corrections are made.
8. If necessary, sellers add notes to the offer. Notes are made in a separate document when sellers, based on their expertise on window products and their use, discover possible mistakes or inadequacies in an offer.
9. A printout of the completed offer is made.
10. To prevent mistakes, offers entered into the system are controlled against customer's specifications. For example, specifications regarding number of products and product characteristics. In this activity, offers which exceed a given value are co-controlled by a colleague seller.
11. If necessary corrections are made.
12. If corrections are made in activity eleven a new printout is made.
13. A second control is made, this time to secure that offered products are within framework conditions. One example might be that products have the right specifications regarding glass thickness according to the determined business standard. Another example is that products are within the max/min size and weight limits according to the same standard.
14. If framework conditions are not met, necessary corrections are made.
15. When framework conditions are not met an approval is necessary. If customer requirements do not comply with framework conditions, sellers send a product specification request to the technical department.
16. When a technician receives a product specification request from a salesperson, the technician assess whether the request is justifiable and decides whether to give an approval or not.
17. If necessary corrections are made.
18. The next step in the offer registration process is to enter calculation of prises.
19. A discount is estimated and registered in the system. Some customers have prices regulated by contracts. For others, a discount is given based on certain guidelines and the seller's judgement regarding gross margin, market situation and current competition.
20. A printout is made on copy paper and the offer is split.
21. The offers estimate is sent to the customer and offer attachments are sent to the customer.
22. A copy is placed in a box in the sellers' office.
23. Alpha's customer presents and discusses the offer estimate with the end user.
24. In some cases the seller initiates a meeting with the customer, the end user and an internal technical expert to discuss appropriate product solutions.
25. In such a meeting, the technical expert is used to present Alpha's product and give advice regarding the end users product specification needs.
26. A follow-up process precedes the handover (and presentation) of the offer estimate.

Further extensions of the process modelling technique

In this study, I needed to compare business process models before and after the deployment of an ERP system module. However, I was unable to find a tool or technique that helped practitioners or researchers compare process models. Therefore, I have further extended the modelling technique to compare and contrast process models and to portray business process change.

Compare and contrast business process models

I found that activities were modified, new or redundant. Therefore, I have applied notations to symbolise these three types of change. The notation I have used is illustrated in Figure III.13, and described below the figure.

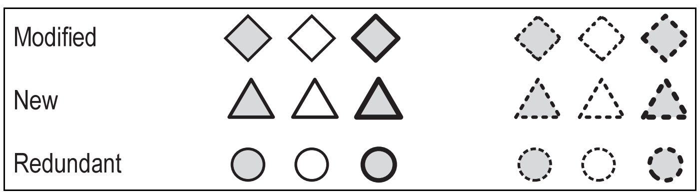

Figure III. 13 Symbols used to illustrate change in business processes

Activities that are performed differently in the work process after the deployment of new software are shown with a diamond-shaped activity box in the after process. Thus, a triangle-shaped activity box may indicate different types of change, such as a change related to how the activity is performed, who is responsible for the performance, or the resources required to perform the activity.

New activities that are enabled or supported by the system are indicated with a triangle-shaped activity box in the after process. Redundant activities are shown with a circle in the before process.

To compare business models from before and after the deployment of an ERP system module, I placed the before and after business process models side by side. To keep track of the activities that were comparable, I drew construction lines. The lines were especially helpful when explaining the business process development in Alpha to colleagues, who were unfamiliar with the business process and the modelling technique. I applied two types of helping lines as illustrated in Figure III.14.

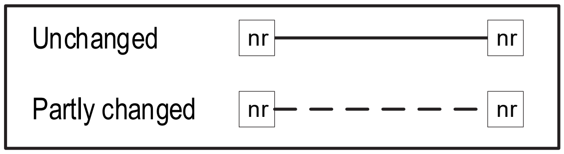

Figure III. 14 Construction lines to support the comparison of business process models

The numbers are related to the descriptions of each activity. In addition, the numbering to the right (before) and the left (after) was necessary to support the comparison of activities. A solid line between the two activities indicates that the activities have remained unchanged. A stippled line indicates that the content is partly changed and partly unchanged. No line from or to another activity indicates that the activity is either redundant or new.

Illustration

Figure III.15 gives an overview of the modelling technique, illustrated with data from the offer registration process in Alpha before and after the implementation of an ERP system module.

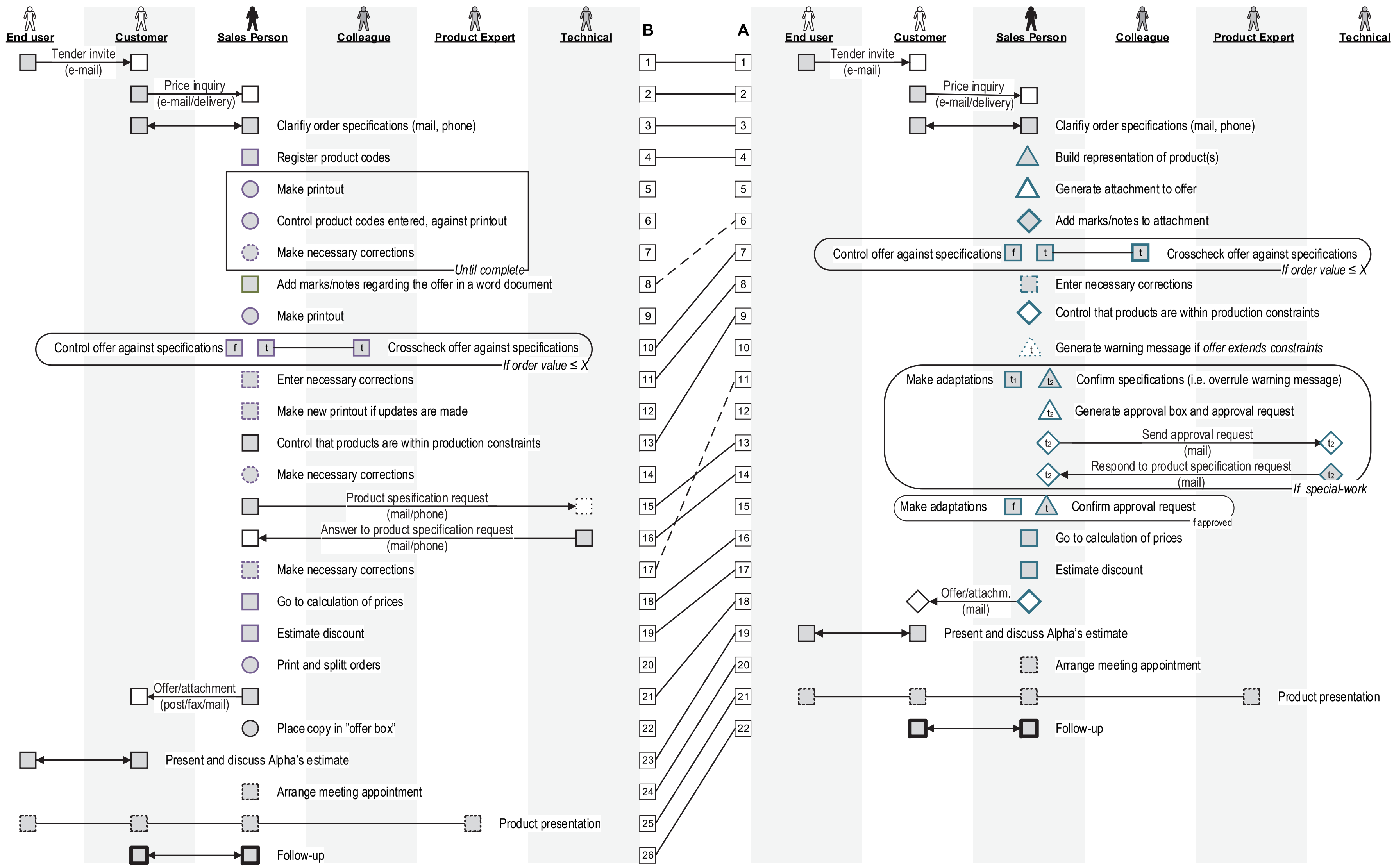

Figure III. 15 Illustration with data from this study

Strengths and limitations of the extended modelling technique

In this section, I compare the adapted and extended modelling technique to the original RIC modelling technique by Iden (2007, 2009). Thereafter, I discuss my experiences of applying my modelling technique to analyse business processes change and organisational effectiveness.

Adaptations and extensions of notation

I have extended the notation of the RIC modelling technique with the selection structure from JSP (Jackson, 1975). The extension of the notation to include selections enables business process modellers to portray business processes more accurately.

In the original RIC modelling technique, notation for business process change is not included. I have extended the notation by including notations for three different types of change. These change types are: modified activities, new activities and redundant activities. The modified and new activities are illustrated in the after-process, and the redundant activities are illustrated in the before-process.

Placing the before and after process side by side allowed me to compare the models and to obtain a visual overview of how the work processes had changed. The two sides of the model are easy to compare, see, for example Figure 7.9 illustrating the production-planning process before and after the implementation of the production-planning module. Hence, the modelling technique is suitable for comparing processes and highlighting change.

Use of the extended technique for analysis and explanation

In this study, I used the graphical models to illustrate how the work processes had changed after the implementation of an ERP system. I believe that the extended process modelling technique is primarily useful to support researchers in the development of models to analyse and explain work process changes. I have found the technique useful to enhance my own understanding of work process change and when I explained such change to others, as mentioned below:

The extensions enabled me to maintain an overview of the main changes after the implementation of an ERP system. Furthermore, by emphasising how work processes had changed, the graphic models supported the assessment of if and how the changes influenced organisational effectiveness.

I found the models useful in interviews with key employees to validate my understanding of how they performed their work processes, and to corroborate my understanding of how the work processes had changed after the ERP system implementation project. Furthermore, I found the work process models useful to communicate my analysis and explanations to other researchers. In addition, the models were useful to explain and demonstrate how work processes had changed to people unfamiliar with process modelling techniques or the work processes in Alpha. I used the models by pointing to, for example, the triangles and circles to explain what was new and what was redundant after the ERP system implementation project.

The original RIC modelling technique was developed for practitioners wanting to learn how to model and analyse processes to develop new and better processes (Iden, 2009). The extended technique supports researchers and managers in identifying actual changes and assessing how an ERP system implementation project may affect organisational effectiveness. The extensions were influenced by my research needs. Thus, the modelling technique should be applied to model other work processes and extended further according to the researchers' needs. Applying the technique in several studies, comparing and assessing work processes before and after the implementation of computerised systems, may enhance the understanding of how such implementation projects may change work processes and influence organisational effectiveness.

Appendix IV – Documentation of the work process modelling

In this appendix, I have gathered the process models that I apply in this study. I modelled and described work processes related to the sales process and the production-planning process in Alpha. I used the colour-codes shown in Figure IV.1 to indicate the IT systems applied in the work processes:

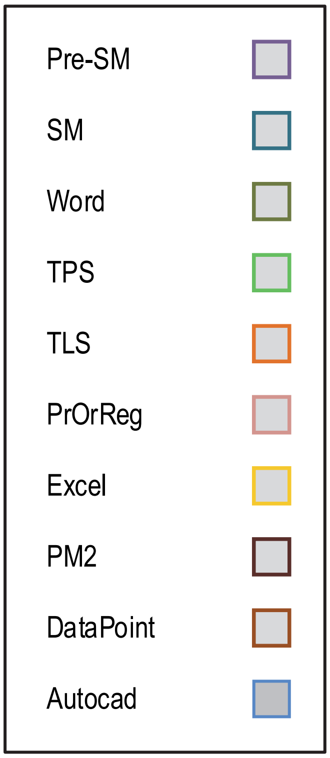

Figure IV. 1 Notation for IT systems applied in the work processes in Alpha

Pre-SM offer registration:

The first process model portrays the pre-SM offer registration process, as presented in Figure IV. 2. In this process model, all roles and activities pertaining to the offer registration process before the implementation of SM are modelled. Below the figure, the process activities are listed and described, with references to the model.

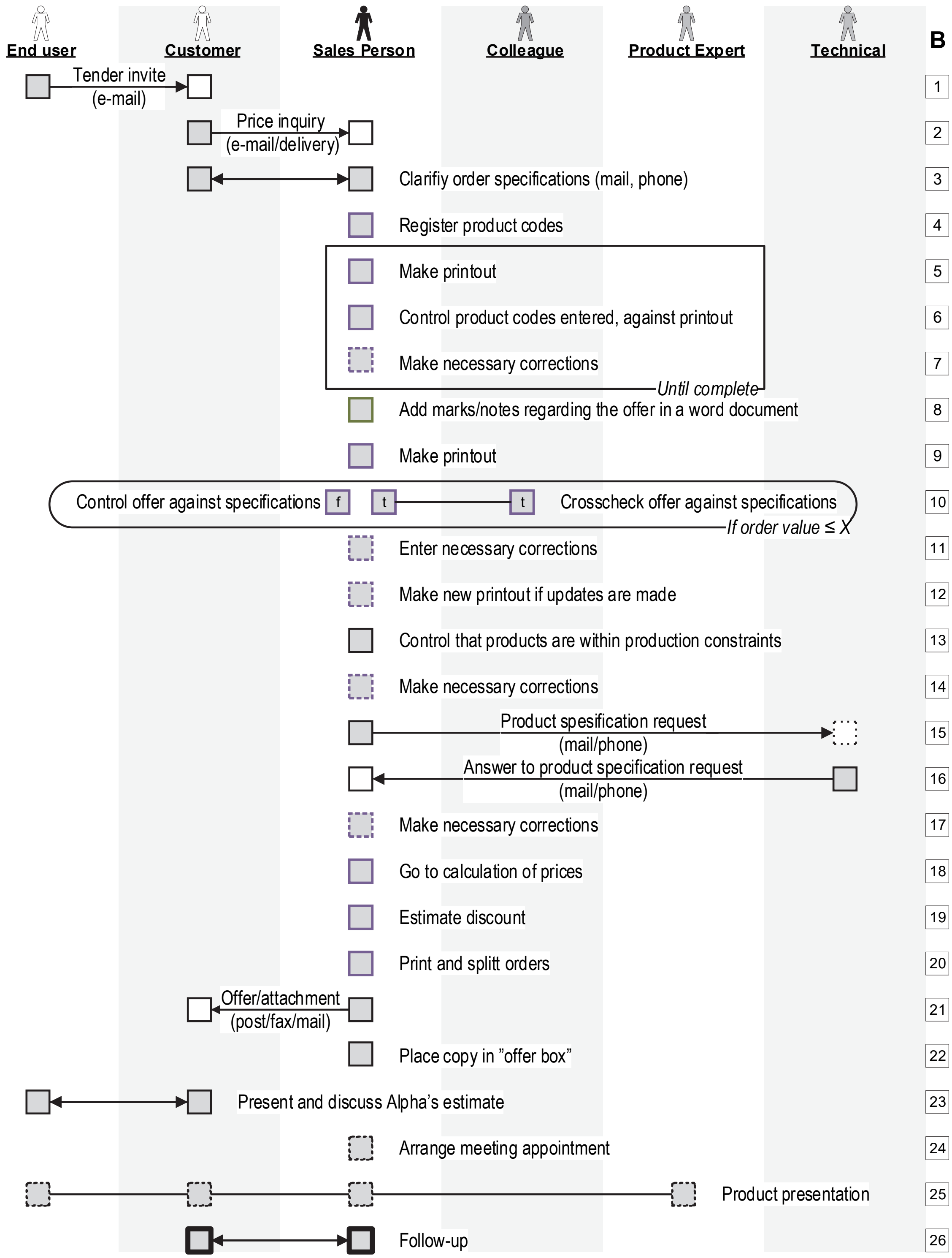

Figure IV. 2 The pre-SM offer registration process

1. This process starts with a tender invite from the end user, in which one or more of Alpha's customers is invited. In this case end users are the customers of Alpha customers.
2. Based on technical requirements provided in the tender invite, the customers place a price inquiry to Alpha.
3. Often clarifications regarding offer specifications are required. This clarification requires communication between customer and seller. For example, if a customer is building a school, that may require a particular type of glass according to current building regulations.
4. Product codes are registered in the pre-SM system, which is a code-based system. When a seller enters product codes into the system a list of codes representing window specifications are shown in the user interface on the screen.
5. When new codes are entered a printout is made from a matrix printer with flimsy paper.
6. A control of the window specification codes entered is performed. A printout is necessary to control that entered codes are correct. The printout provides illustrations of products specified in the offer. This illustration will only appear on printouts and not on the screen. A control of the codes entered is performed by comparing product drawings on the printout against code specifications from the customer (gathered in activity three). For example, when windows are placed in close vicinity sellers control the alignment of the window bars.
7. When discrepancies between sellers' intended specifications and product drawings on printout are discovered, necessary corrections are made.

Activities five, six and seven are repeated until the offer printout is completed in accordance with seller's intentions.

8. If necessary, sellers add notes to the offer. Notes are made in a separate document when sellers, based on their expertise on window products and their use, discover possible mistakes or inadequacies in an offer.
9. A printout of the completed offer is made.

10. To prevent mistakes, offers entered into the system are controlled against customer's specifications. For example, specifications regarding number of products and product characteristics. In this activity, offers which exceed a given value are co-controlled by a colleague seller.
11. If necessary corrections are made.
12. If corrections are made in activity eleven a new printout is made.
13. A second control is made, this time to secure that offered products are within framework conditions. One example might be that products have the right specifications regarding glass thickness according to the determined business standard. Another example is that products are within the max/min size and weight limits according to the same standard.
14. If framework conditions are not met, necessary corrections are made.

Activity thirteen and fourteen are repeated until all products are controlled.

15. When framework conditions are not met an approval is necessary. If customer requirements do not comply with framework conditions, sellers send a product specification request to the technical department.
16. When a technician receives a product specification request from a salesperson, the technician assess whether the request is justifiable and decides whether to give an approval or not.
17. If necessary corrections are made.
18. The next step in the offer registration process is to enter calculation of prises.
19. A discount is estimated and registered in the system. Some customers have prices regulated by contracts. For others, a discount is given based on certain guidelines and the seller's judgement regarding gross margin, market situation and current competition.
20. A printout is made on copy paper and the offer is split.
21. The offers estimate is sent to the customer and offer attachments are sent to the customer.
22. A copy is placed in a box in the sellers' office.
23. Alpha's customer presents and discusses the offer estimate with the end user.

24. In some cases the seller initiates a meeting with the customer, the end user and an internal technical expert to discuss appropriate product solutions.
25. In such a meeting, the technical expert is used to present Alpha's product and give advice regarding the end users product specification needs.
26. A follow-up process precedes the handover (and presentation) of the offer estimate.

Post-SM offer registration:

This process model portrays the post-SM offer registration process, as presented in Figure IV.3. The activities pertaining to the offer registration process after the implementation of SM are described and listed below the figure, with references to the model.

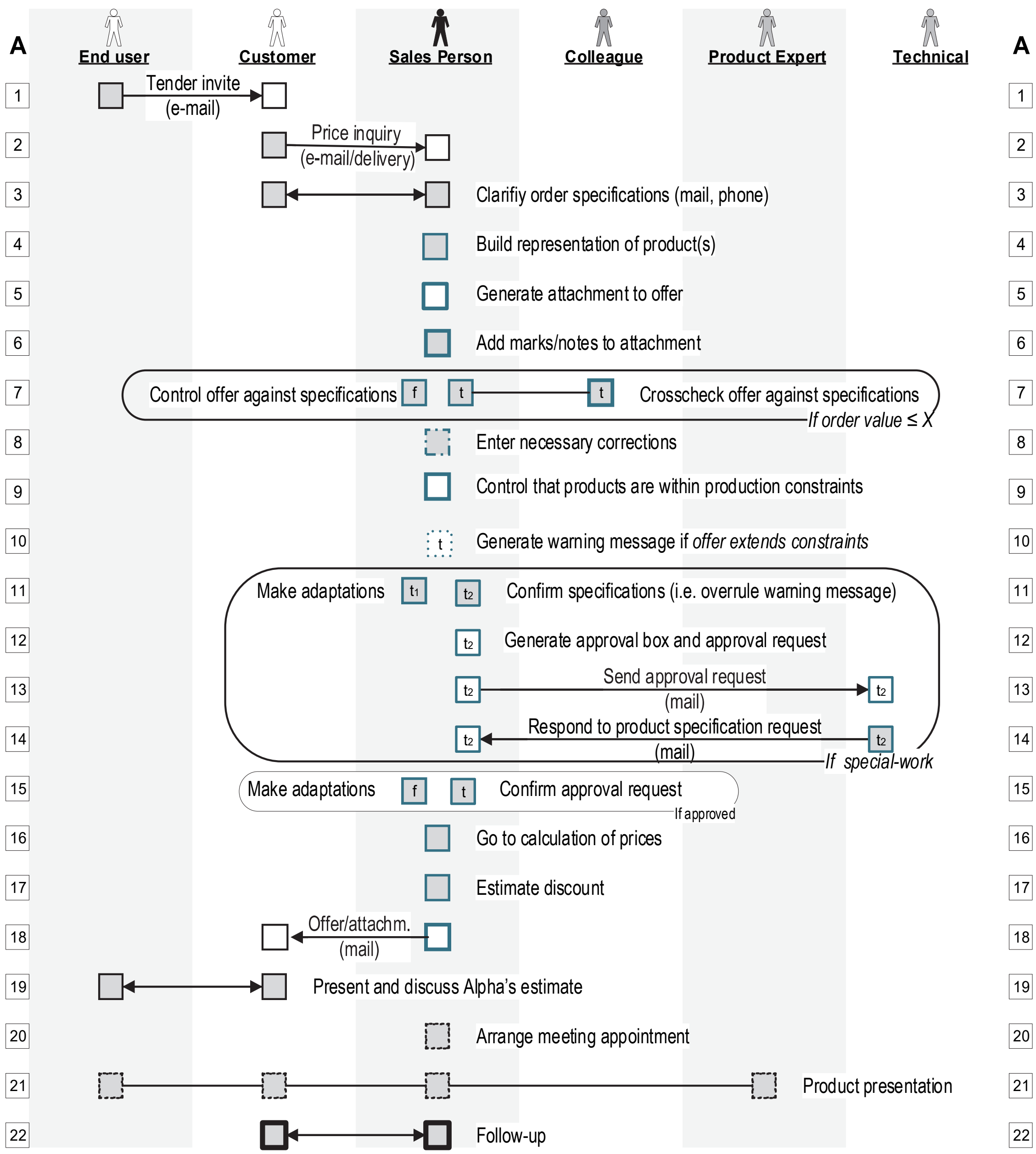

Figure IV. 3 The pre-SM offer registration process

1. This process starts when one of Alpha's customers responds to a tender invite.
2. This solicitation may result in a price inquiry to Alpha based on technical requirements provided by the end user.
3. Often clarifications regarding offer specifications are required.
4. Product specifications are registered. SM is a window-based system in which sellers may build and illustrate window products on the screen.
5. When offer specifications are entered, the offer (with attachments) is generated.
6. Seller's expertise on window products and their use may cause the discovery of possible mistakes or inadequacies in customer requests. Therefore, if necessary, sellers add notes regarding possible improvements of the requirements, in the offer attachment.
7. When an offer is registered into SM, the system automatically controls that the products meet framework conditions.
8. If necessary, corrections are made
9. The offer is controlled against the customer's specifications. For example, specifications regarding number of products and product characteristics.
10. If framework conditions are not met, a warning message is automatically generated.
11. The sellers then have a choice between two alternative actions. Either specifications are confirmed as-is or changes are made to meet framework conditions.

If specifications are confirmed as-is, the activities placed in the column under the *confirm specifications* activity-box take place.

12. When sellers confirm specifications that disregard framework conditions an approval is necessary to precede. Automatically, a product specification request is generated
13. Automatically, a product specification request is sent to the technical department.
14. A technician decides whether to approve or decline the offer specification request and sends a response.
15. When the product specification request is sent the system generates an approval request. Sellers must confirm approval request to precede.
16. The next step in the offer registration process is to enter the calculation of prises.

17. Often a discount is estimated and registered into SM.
18. The offer estimate with pertaining attachments are sent to the customer.
19. Alpha's customer presents and discusses the offer estimate with the end user.
20. In some cases the seller initiates a meeting with the customer, the end user and an internal technician expert to discuss appropriate product solutions.
21. In such a meeting (see activity 20), the technical expert is used to present Alpha's product and give advice regarding the end users product specification needs.
22. A follow-up process precedes the handover (and presentation) of the offer estimate.

Pre-SM offer follow-up:

This process model portrays the pre-SM offer follow-up process, as presented in Figure IV.4. The activities pertaining to the offer follow-up process before the implementation of SM are described and listed below the figure, with references to the model.

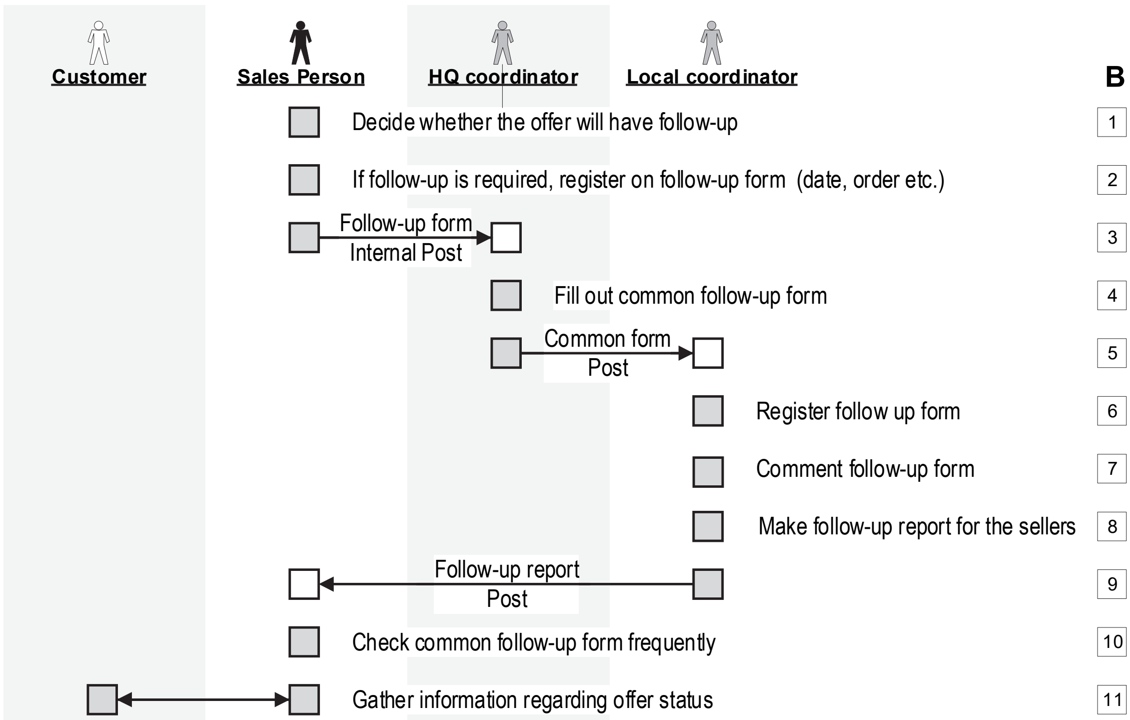

Figure IV. 4 The pre-SM follow-up process

1. The pre-SM offer follow-up process starts with the sellers' decision to follow up or not to follow up on an offer.
2. If follow-up is required, some data regarding the offer such as a follow-up date is registered on a follow-up form.
3. At regular intervals, the follow-up form is sent to the sales coordinator at the headquarters.
4. The sales coordinator collects and systematises offers in a new follow-up form that is common to all sellers in a sales unit.
5. The sales coordinator sends the common follow-up form to local coordinators at each sales office.
6. The local coordinators register the follow-up forms.

7. The local coordinators pass remarks on the follow-up forms.
8. Weekly, the local coordinators make follow-up reports.
9. The local coordinators send follow-up reports to the sellers in their sales unit.
10. To contact customers at the right time sellers must regularly check follow-up dates in the common follow-up form.
11. Sellers contact customers and ask questions regarding the development/status of specific offers. The interaction with customers to retrieve offer status data may involve a collection of activities conducted at different times and through different channels (e.g. phone, mail, etc.). Normally, follow-up activities imply asking questions, such as whether the customer is given a particular contract, when a certain decision is expected to be made, if there are known postponements, how a decision is made or will be made, etc. Sellers also investigate whether Alpha's offer has been used in the process to gain a contract. If Alpha's offer is not used, sellers may try to find out which contractors have gained which contracts and whose offers were used in the process. If possible, some details on the used offer are retrieved.

Post-SM offer follow-up:

This process model portrays the post-SM offer follow-up process, as presented in Figure IV.5. The activities pertaining to the offer follow-up process after the implementation of SM are described and listed below the figure, with references to the model.

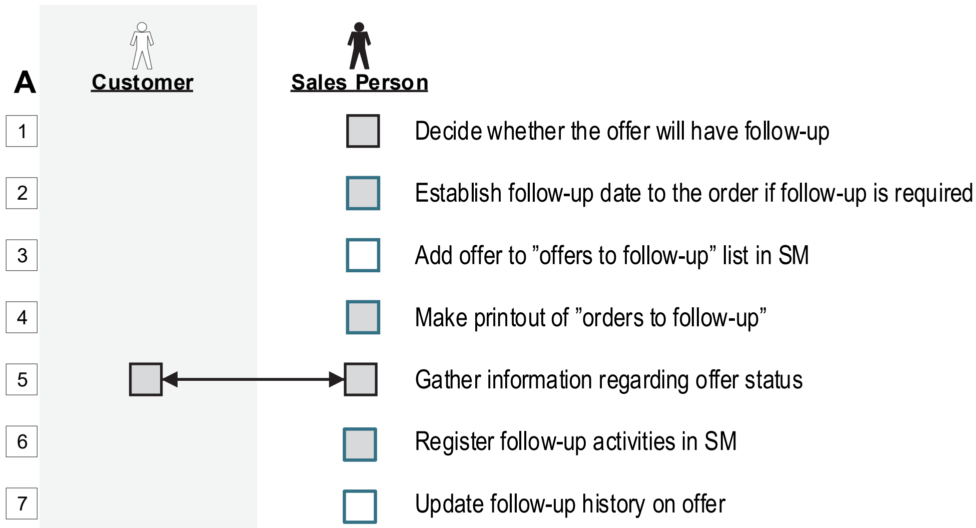

Figure IV. 5 The post-SM follow-up process

1. The post-SM offer follow-up process starts similarly to the pre-SM process, with the sellers' decision to follow up or not to follow up on an offer.
2. If follow-up is required the seller must decide a date for follow-up, which is then registered in connection to the specific offer.
3. Automatically, when a follow-up date is entered, the offer is added to the "follow-up list" in SM.
4. Regularly, a printout of the follow-up list is made. This list can be classified by county, salesperson or branch office.
5. Sellers contact customers and ask them questions regarding the development/status of specific offers. Normally, follow-up activities imply asking questions, such as whether the customer is given a particular contract, when a certain decision is expected to be made, if there are known postponements, how a decision is made or will be made, etc. Sellers also investigate whether Alpha's offer has been used in the process to gain a contract. If Alpha's offer is not used, sellers may try to find out which contractors have

gained which contracts and whose offers were used in the process. If possible, some details on the used offer are retrieved.

6. Follow-up activities performed are registered in the SM system.
7. When data is entered it is automatically added to the history of the offer in question.

Pre-SM order registration:

This process model portrays the pre-SM order registration process, as presented in Figure IV.6. The activities pertaining to the order registration process before the implementation of SM are described and listed below the figure, with references to the model.

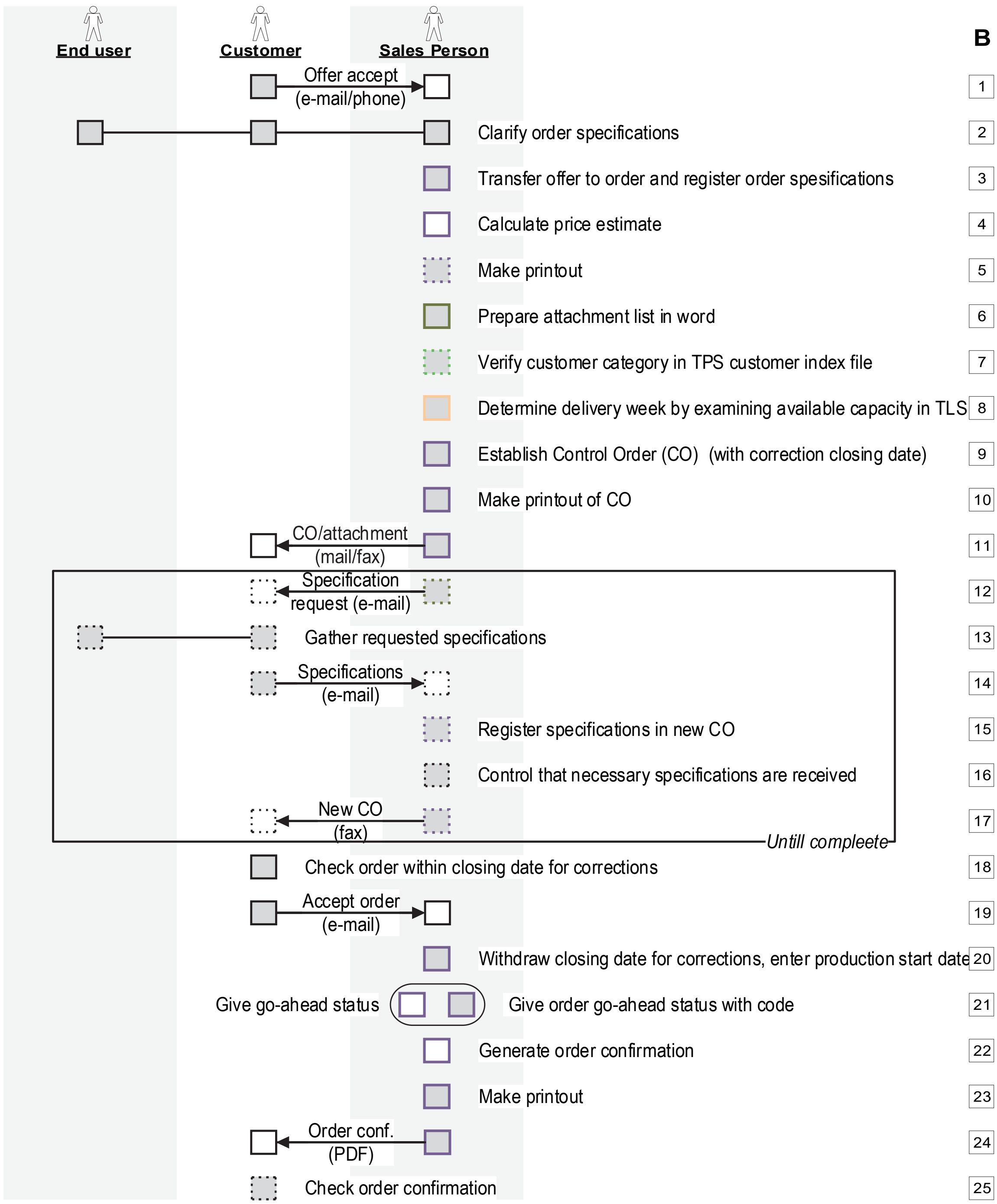

Figure IV. 6 The pre-SM order registration process

1. The order registration process starts when a customer accepts an offer.
2. When orders are confirmed, sellers start gathering necessary specification details. In this process sellers contact their customer and the customer then contacts the end user (their customer). The course of this process varies, depending on the individuals holding the roles and their knowledge about available products and end users' needs.
3. Usually orders are based on previous offers. To transfer an offer to an order a status-code is changed. When an order is established, order specifications retrieved from customers are registered.
4. A price estimate is automatically calculated when order specifications are confirmed
5. A printout is made.
6. An attachment to the offer, made in Microsoft Word, is prepared. This attachment lists order specifications: that is, information Alpha needs to deliver the order. This information may be details regarding glass, specific colour choice, window frame breadth, delivery address, delivery week, etc..
7. To determine the delivery week in activity eight, sellers must know whether a customer is a contract or project customer. If customer category is known, sellers go directly to activity eight. If customer type is uncertain or unknown, sellers verify customer category by consulting a customer index file in a third-party system, here named TPS. In this index file contract customers are registered and project customers are not.
8. When customer category is clear, delivery week is determined by first examining available capacity in all factories. Capacity for each factory is displayed in a so-called "traffic light" system, developed in Microsoft Excel. In this system every week is marked by a colour; red indicates that capacity constraints are met for that week. Yellow signifies that remaining capacity is reserved for contract customers only and green means free capacity available for both contract and project customers. Sales personnel place new orders in vacant weeks in the "traffic light" system and register the delivery week in the pre-SM order system.
9. A control order is established. In connection with each control order a closing date for corrections is determined. After this deadline, customers' change requests may be denied or charged as an expense.
10. A printout is made of the control order.

11. The control order attachment is sent to the customer.
12. Often many specification details must be determined before an order can be released to production. If specifications fail to appear, a separate specification detail request is sent to the customer.
13. If the customer receives such a request they need to obtain the details requested from the end user. For example, it is necessary to clarify exactly which colour the end user wants on the products. Sometimes orders refer to unspecified colours from the NCS-colour code system. A description such as an NCS-colour must be further specified because the NCS-colour standard contains 1600 colours. Only when a requested colour is accompanied with a specific NCS-colour code can Alpha meet end users' colour requests.
14. The customer forwards specification details to the seller.
15. The seller establishes a new control order in which the new specifications are registered.
16. The seller controls that requested specifications are received.
17. The seller sends the new control order to the customer.

Activities 12-16 are repeated until all necessary order specifications are retrieved and registered.

18. Customers must see that order specifications are controlled within the closing date for corrections.
19. Customers accept the order by sending an order confirmation to Alpha.
20. Sellers then withdraw the closing date for corrections and enter a production start date.
21. A go-ahead status is obtained automatically when closing date for corrections is withdrawn. However, go-ahead status can also be given manually by changing the order status code in the pre-SM order system.
22. Automatically, an order confirmation is generated.
23. A printout is made.
24. The order confirmation is sent to the customer.
25. Customers may check the order confirmation when received.

Post-SM order registration:

This process model portrays the post-SM order registration process, as presented in Figure IV.7. The activities pertaining to the order registration process after the implementation of SM are described and listed below the figure, with references to the model.

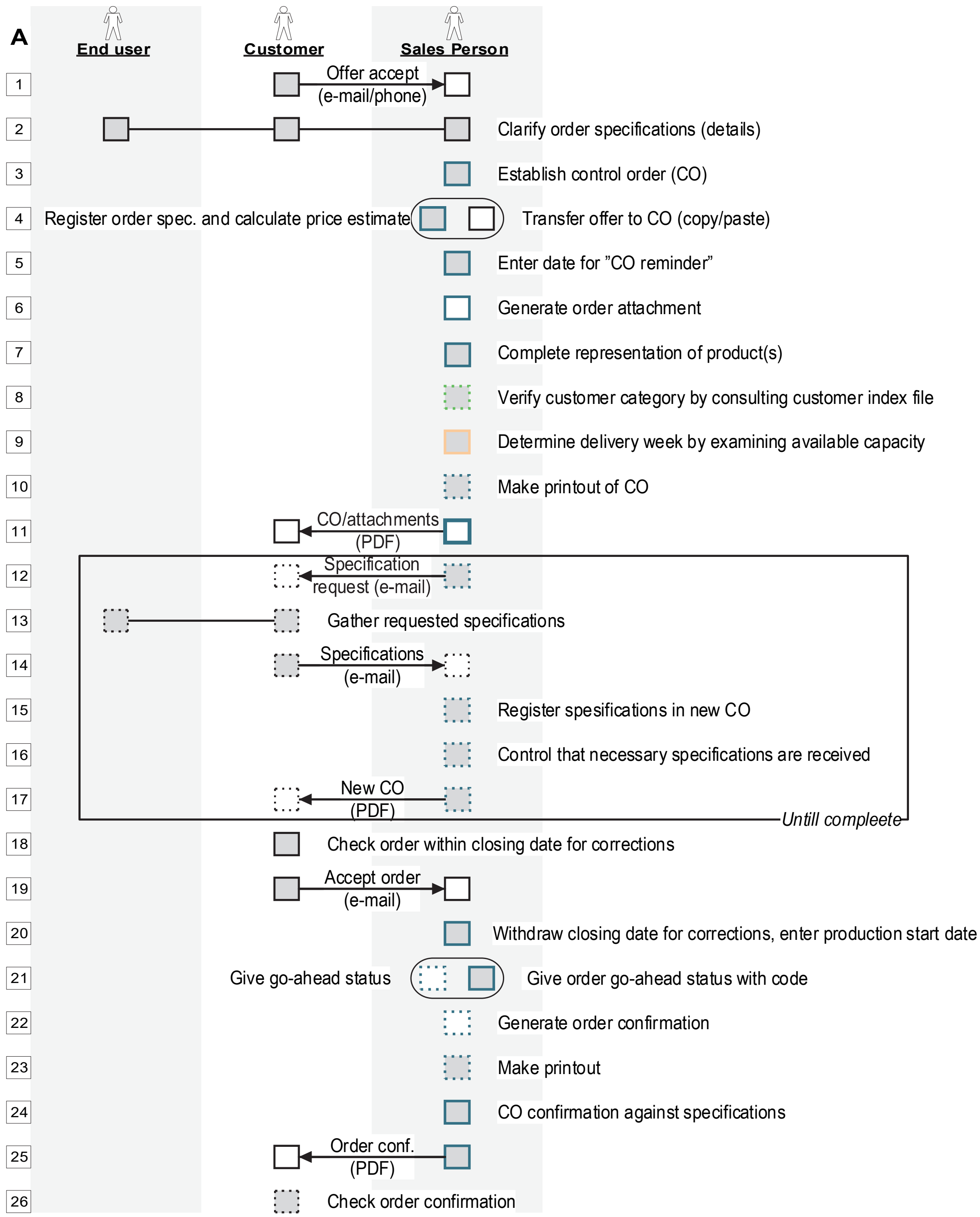

Figure IV. 7 The post-SM order registration process

1. This process starts when a customer accepts an offer.
2. When orders are confirmed, sellers start gathering necessary specification details.
3. A control order is established.
4. Usually orders are based on previous offers. To transfer an offer to an order, a status-code belonging to the offer/order is changed. If an order is not based on a previous offer, sellers register specifications directly into the order and a price estimate is automatically calculated when order specifications are confirmed.
5. Sellers enter a date for control order reminder.
6. An order attachment is generated automatically. In this attachment clarification needs and accompanying deadlines are registered.
7. In the attachment generated in activity six, sellers describe what specifications are missing, for example regarding glass, specific colour choice, window frame breadth, delivery address, delivery week, etc..
8. To determine the delivery week in activity nine, sellers must know whether a customer is a contract or project customer. If customer category is known, sellers go directly to activity eight. If customer type is uncertain or unknown, sellers verify customer category by consulting a customer index file in a third-party system, here named TPS. In this index file contract customers are registered and project customers are not.
9. When customer category is clear, delivery week is determined by first examining available capacity in all factories. Capacity for each factory is displayed in a so-called "traffic light" system, developed in Microsoft Excel. In this system every week is marked by a colour; red indicates that capacity constraints are met for that week. Yellow signifies that remaining capacity is reserved for contract customers only and green means free capacity available for both contract and project customers. Sales personnel place new orders in vacant weeks in the "traffic light" system and register the delivery week in the post-SM order system.
10. A printout is made of the control order.
11. The control order with attachment is sent to the customer.

12. Often, many specification details must be determined before an order can be released to production. If specifications fail to appear, a separate specification detail request is sent to the customer.
13. If the customer receives a specification detail request they need to obtain the details requested from the end user. For example, if it is necessary to clarify exactly which colour the end user wants on the products. Sometimes orders refer to unspecified colours from the NCS-colour code system. A description such as an NCS-colour must be further specified because the NCS-colour standard contains 1600 colours. Only when a requested colour is accompanied with a specific NCS-colour code can Alpha meet end users' colour requests.
14. The customer forwards specification details to the seller.
15. The seller establishes a new control order in which the new specifications are registered.
16. The seller controls that requested specifications are received.
17. The seller sends the new control order to the customer.

Activities 12-16 are repeated until all necessary order specifications are retrieved and registered.

18. Customers must see that order specifications are controlled within the closing date for corrections.
19. Customers accept the order by sending an order confirmation to Alpha.
20. Sellers then withdraw the closing date for corrections and enter a production start date.
21. A go-ahead status is obtained automatically when closing date for corrections is withdrawn. However, go-ahead status can also be given manually by changing the order status code in SM.
22. Automatically, an order confirmation is generated.
23. A printout is made.
24. Sellers control order confirmation against specification, such as that the delivery week in SM meets the delivery date in TPS.
25. Sellers send the order confirmation to the customer.
26. The customers may or may not check the order confirmation when received.

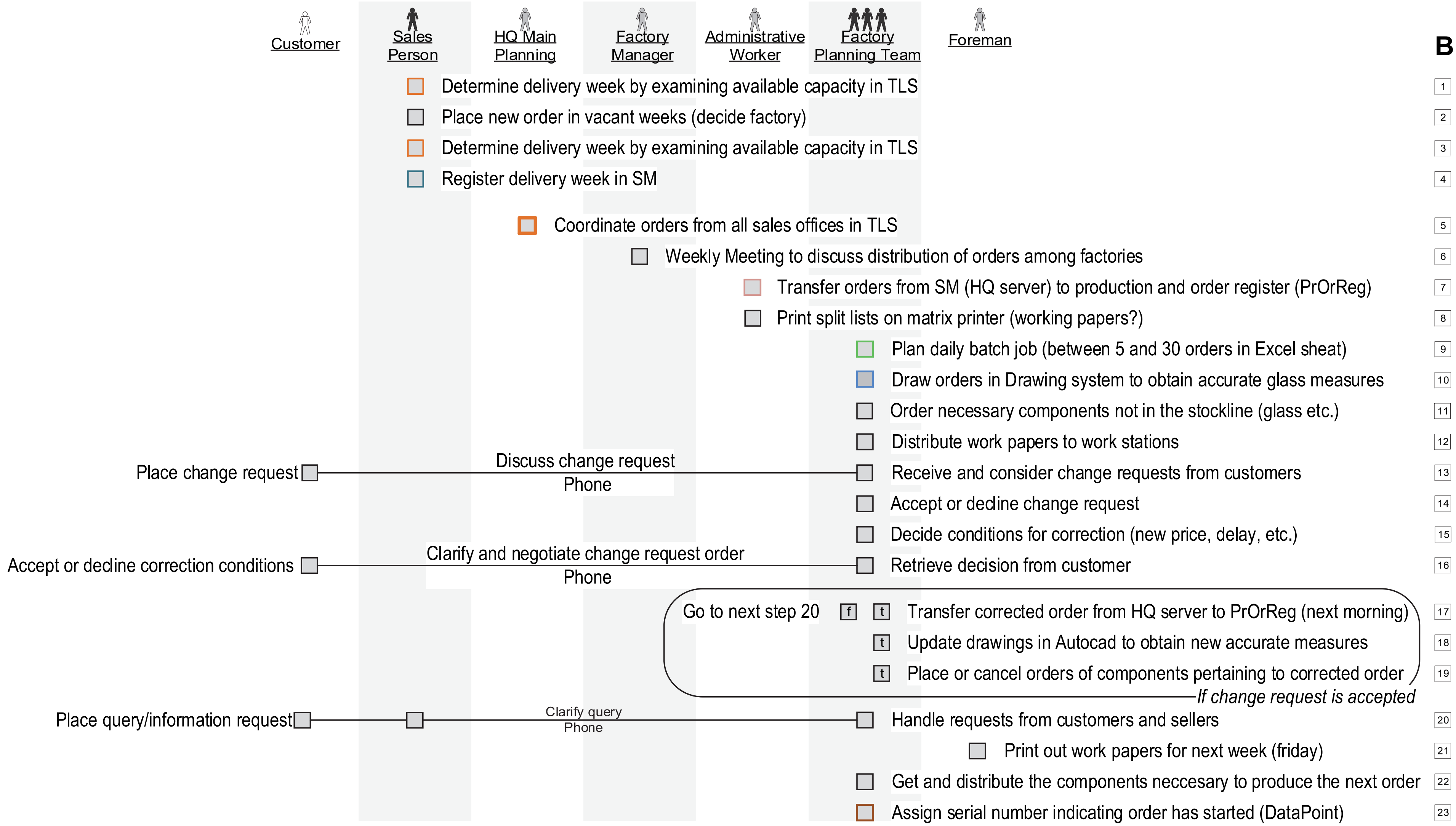

Figure IV. 8 The pre-PM2 production planning process

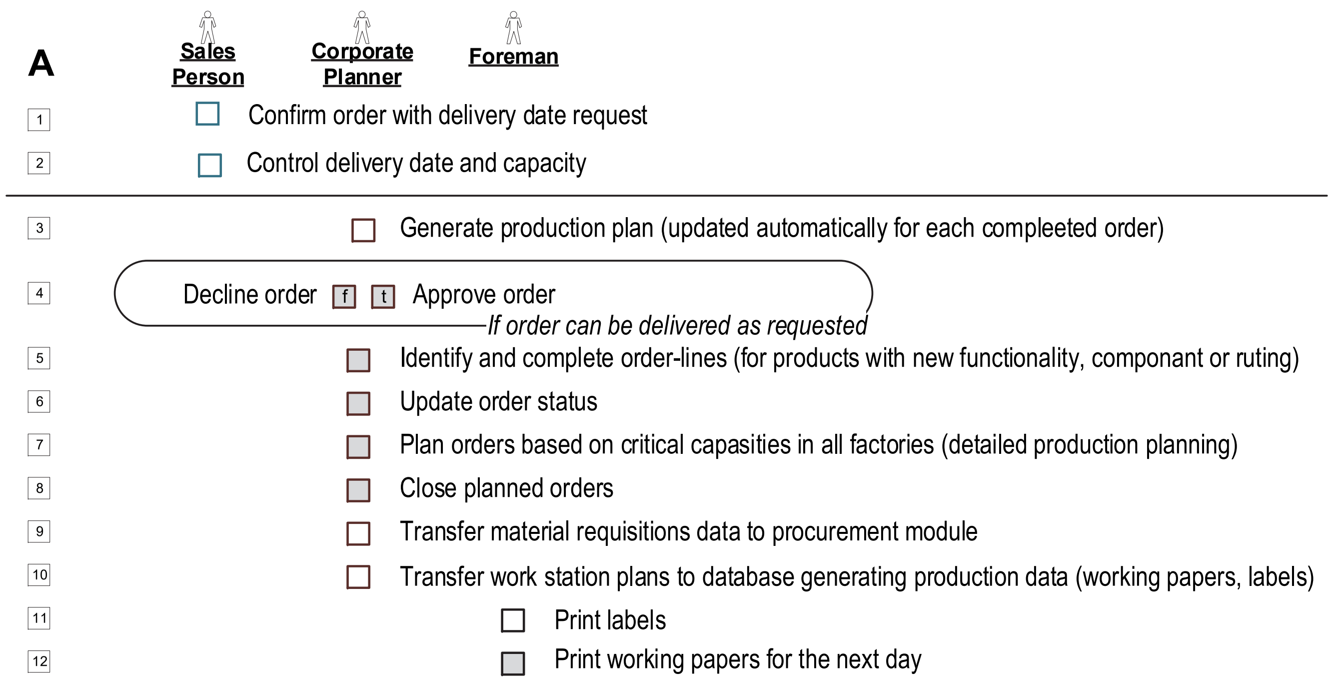

Figure IV. 9 The post-PM2 production planning process

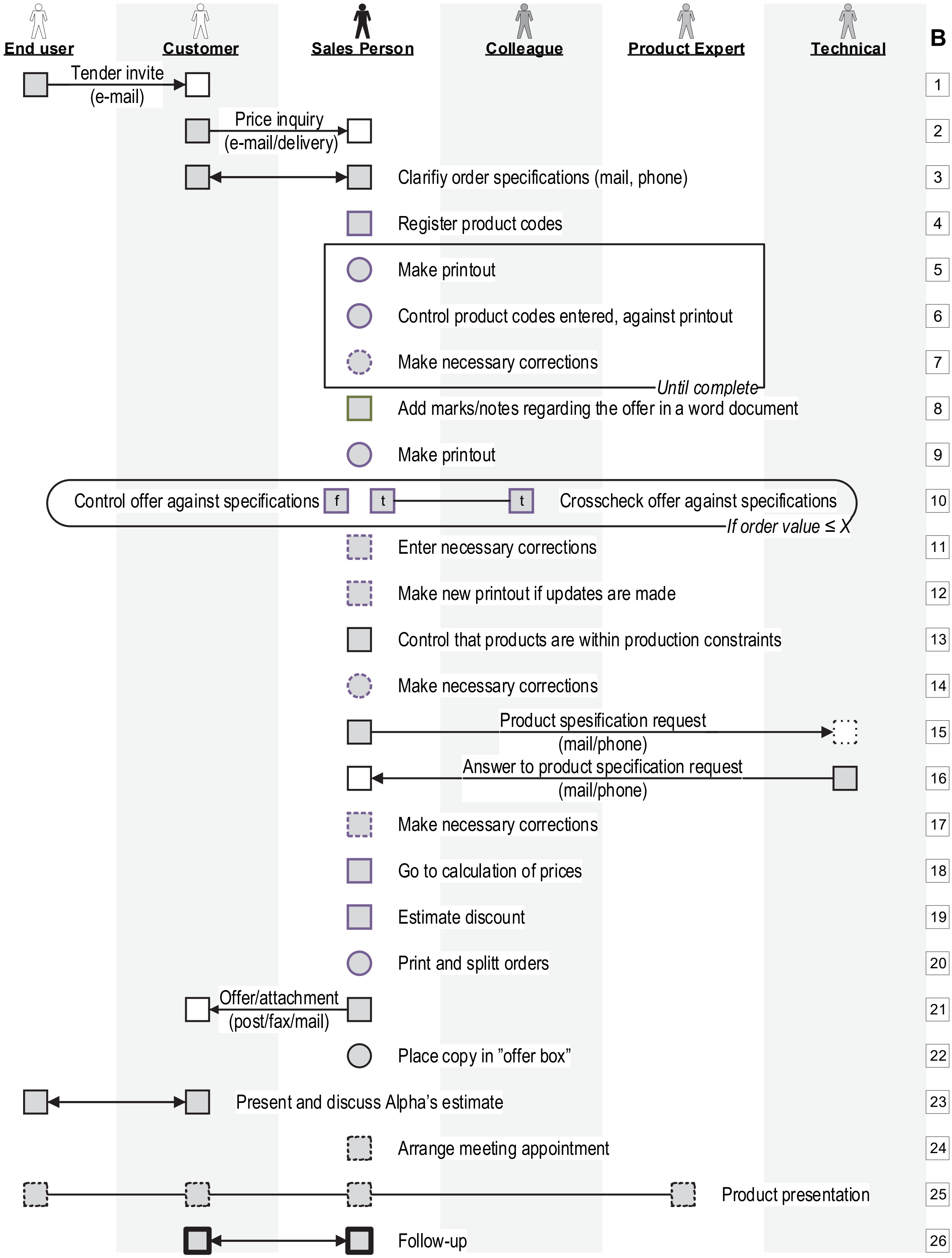

Figure IV. 10 Redundant activities in the pre-SM offer registration process

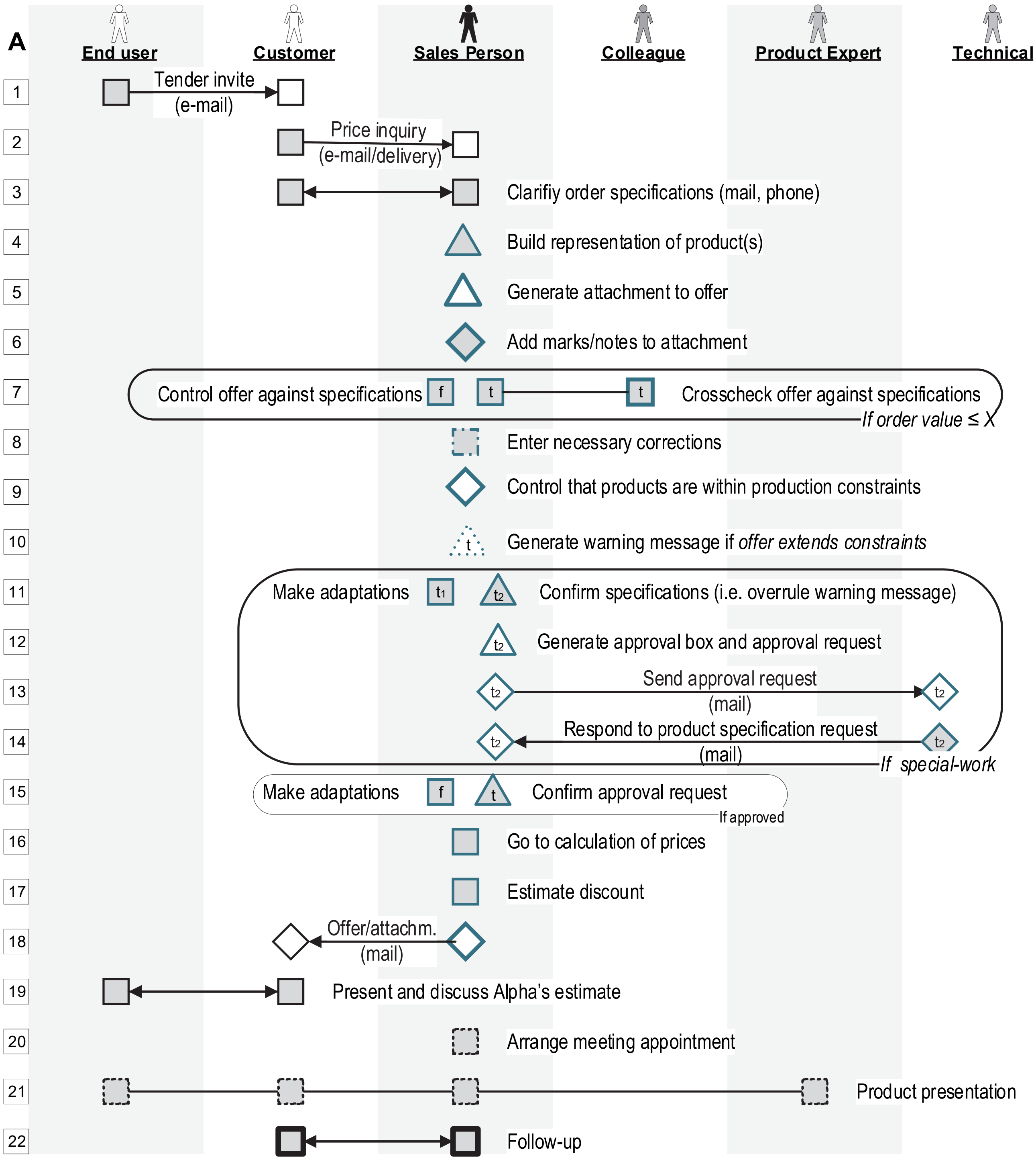

Figure IV. 11 New and modified activities in the post-SM offer registration process

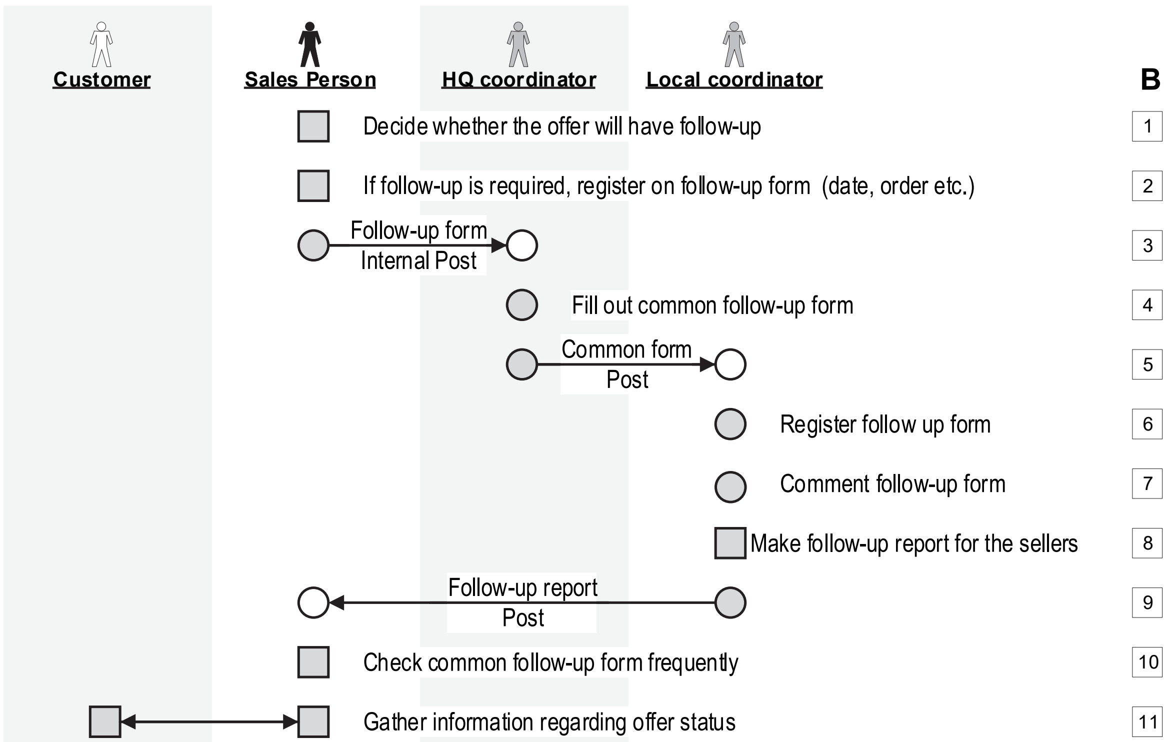

Figure IV. 12 Redundant activities in the pre-SM follow-up process

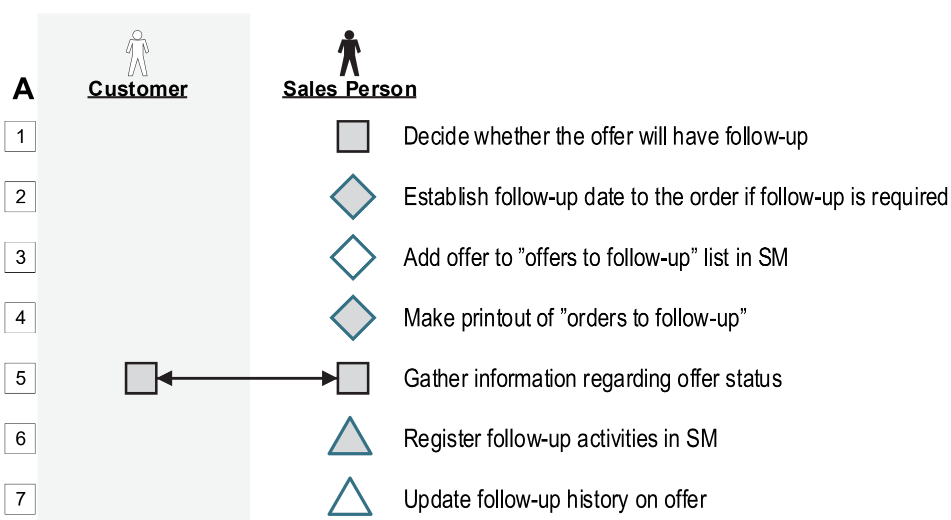

Figure IV. 13 New and modified activities in the post-SM follow-up process

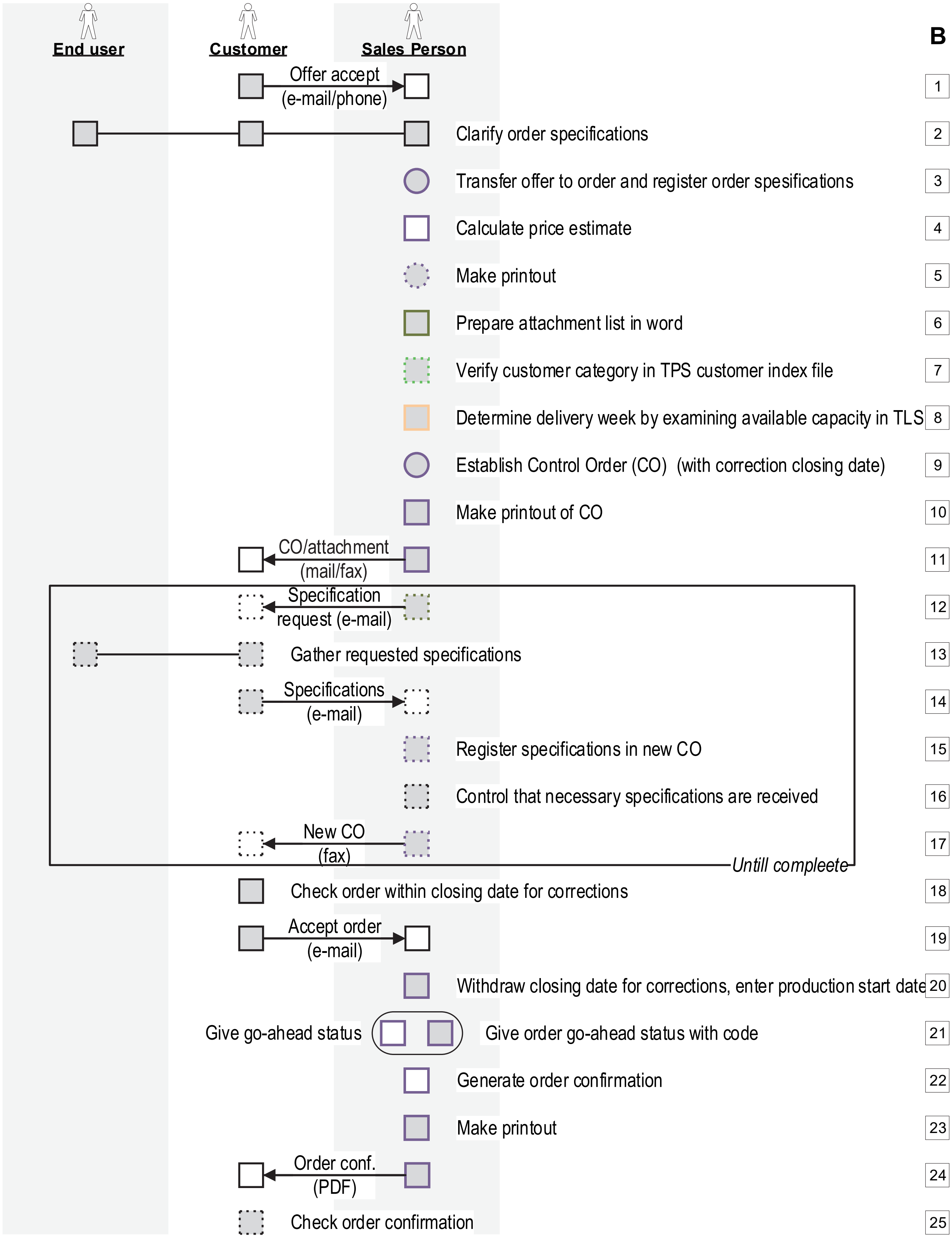

Figure IV. 14 Redundant activities in the pre-SM offer registration process

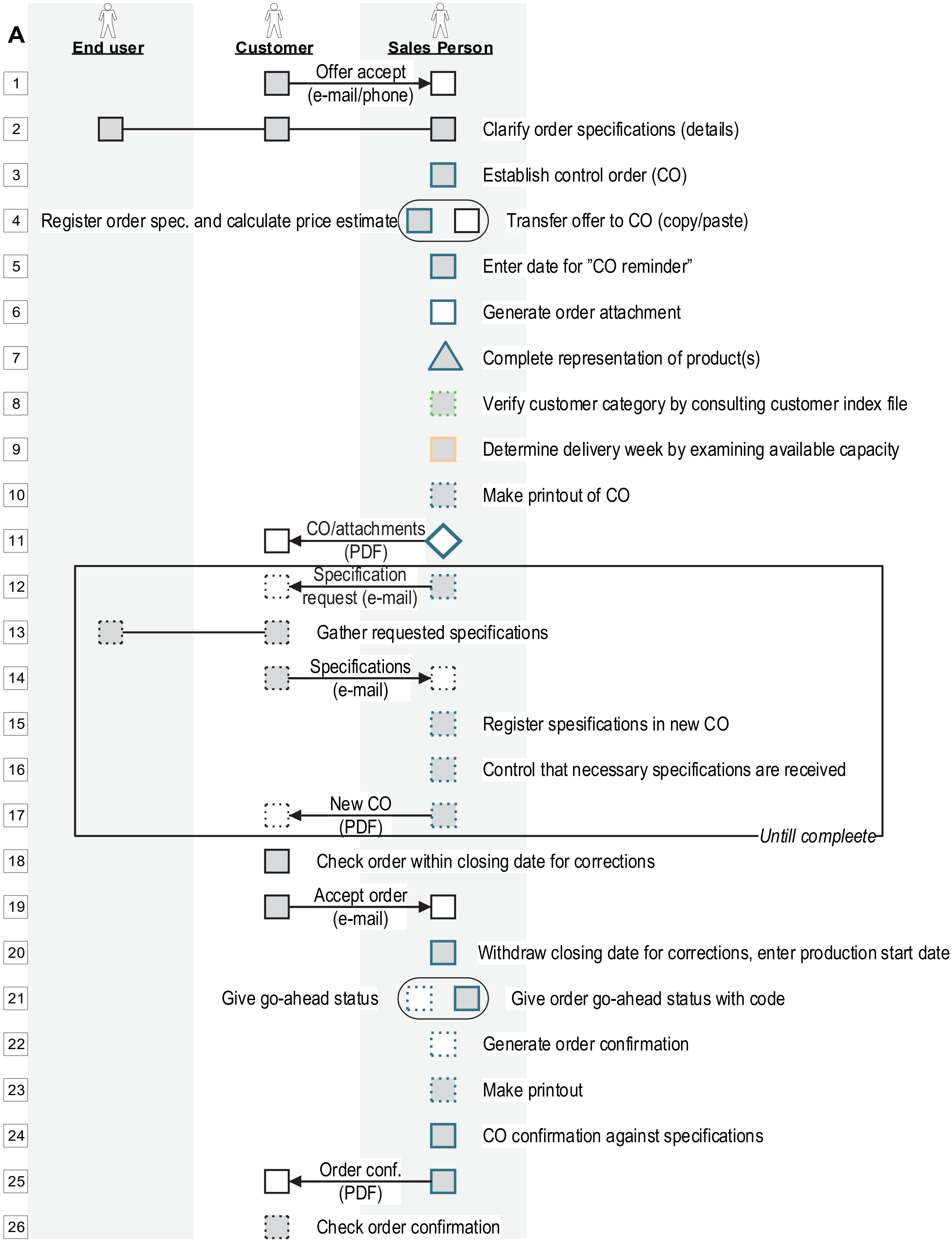

Figure IV. 15 New and modified activities in the post-SM offer registration process

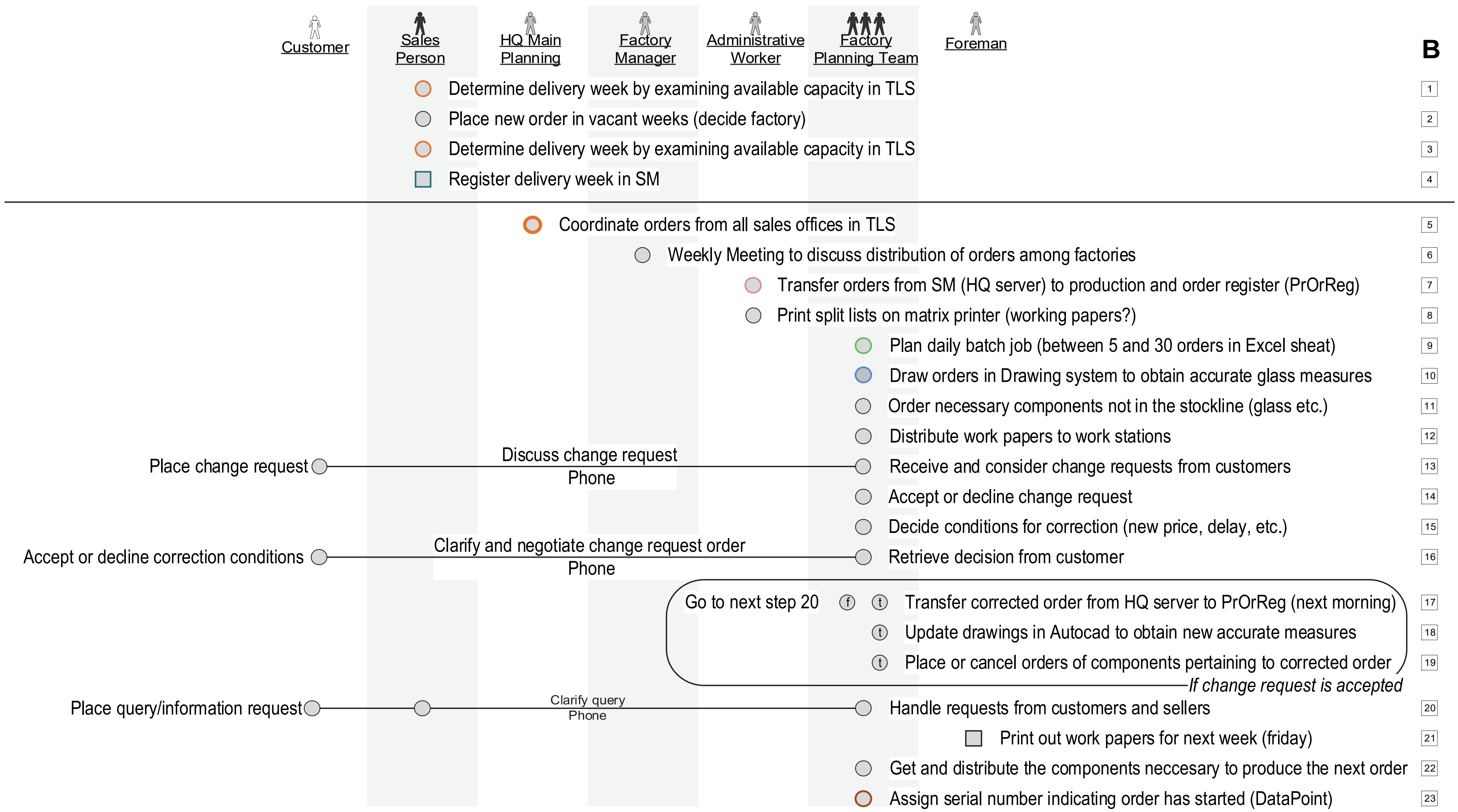

Figure IV. 16 Redundant activities in the pre-PM2 production planning process

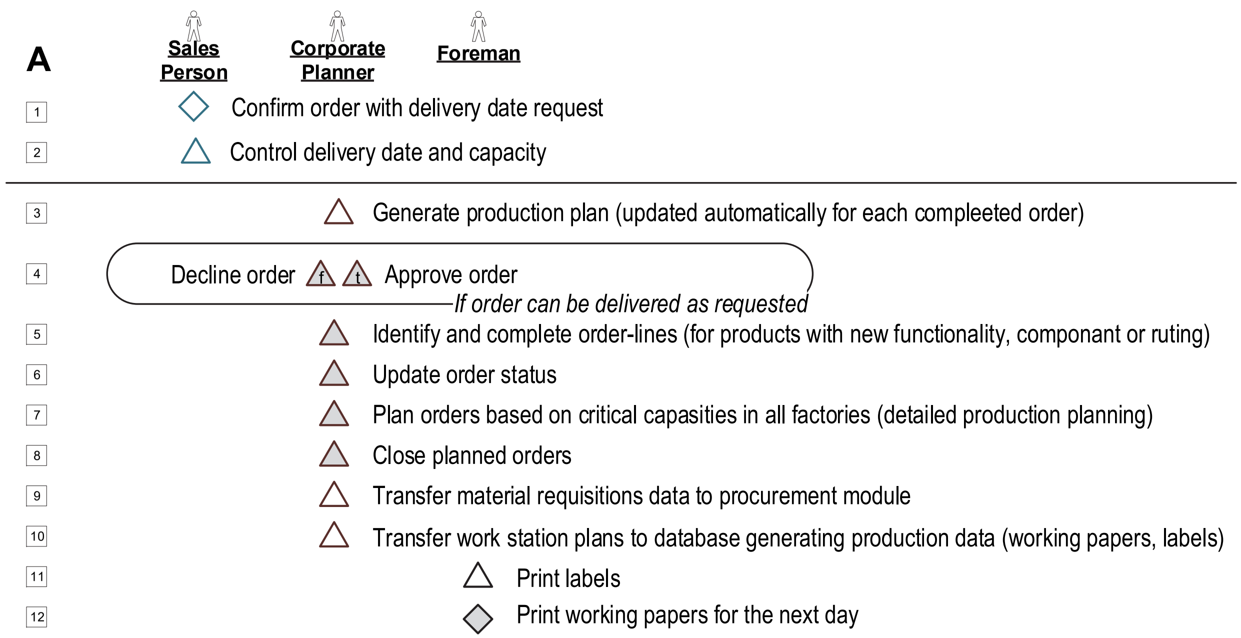

Figure IV. 17 New and modified activities in the post-PM2 corporate planning process

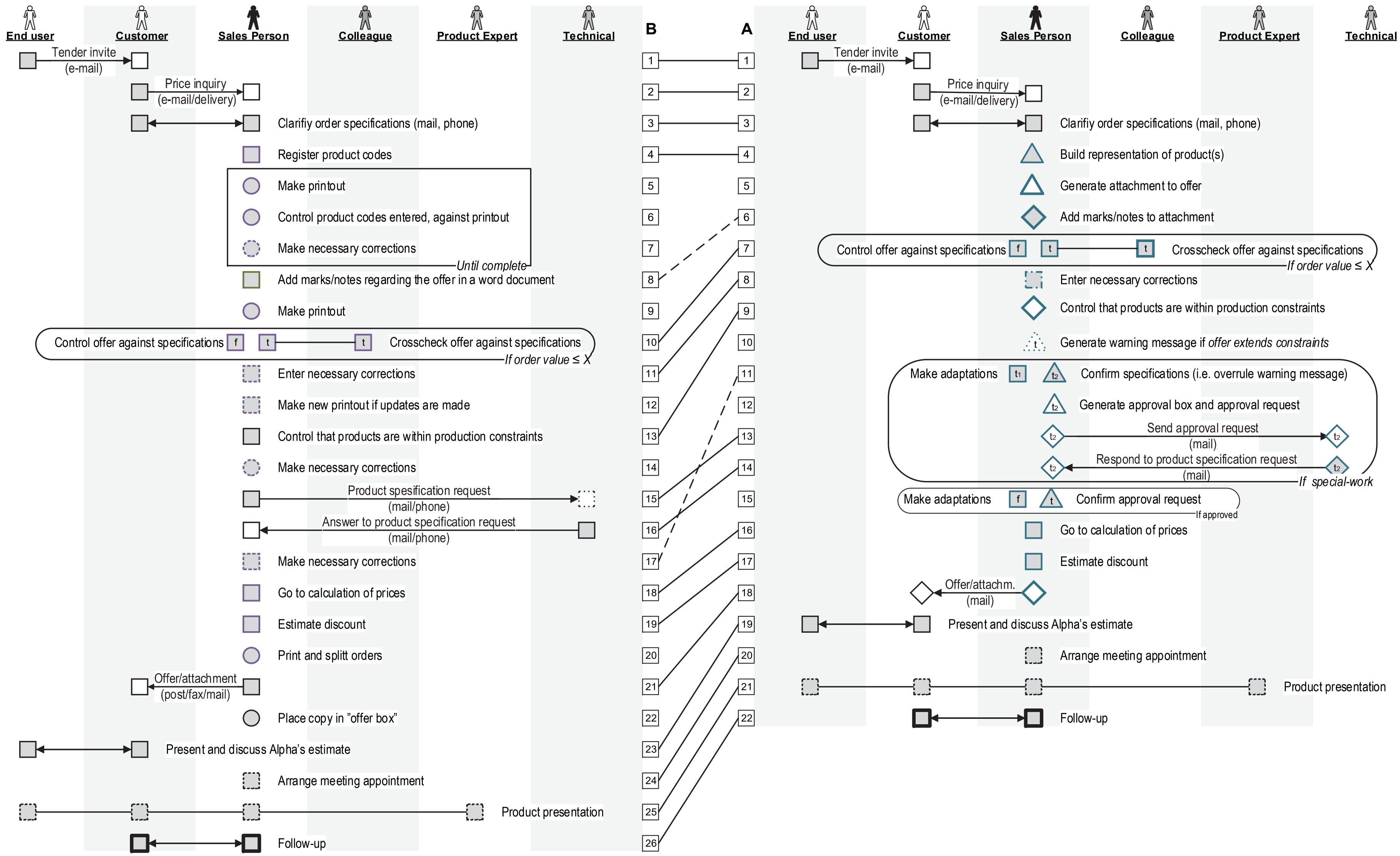

Figure IV. 18 Process model illustrating changes in the order registration process

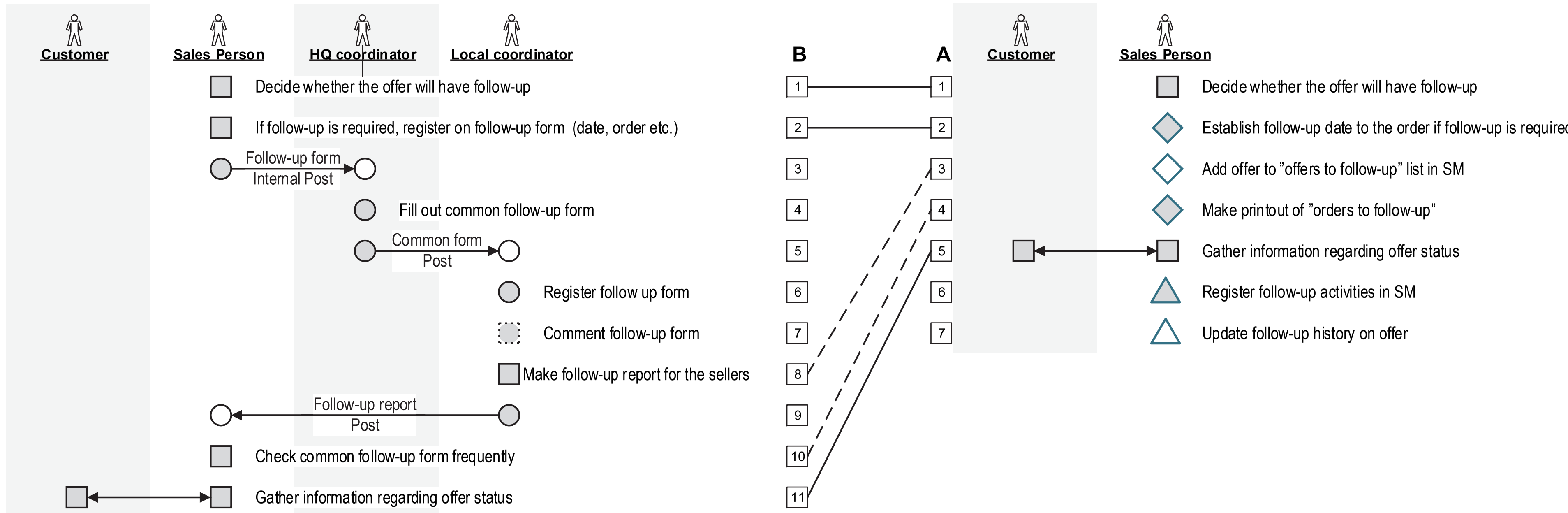

Figure IV. 19 Process model illustrating changes in the offer follow-up process

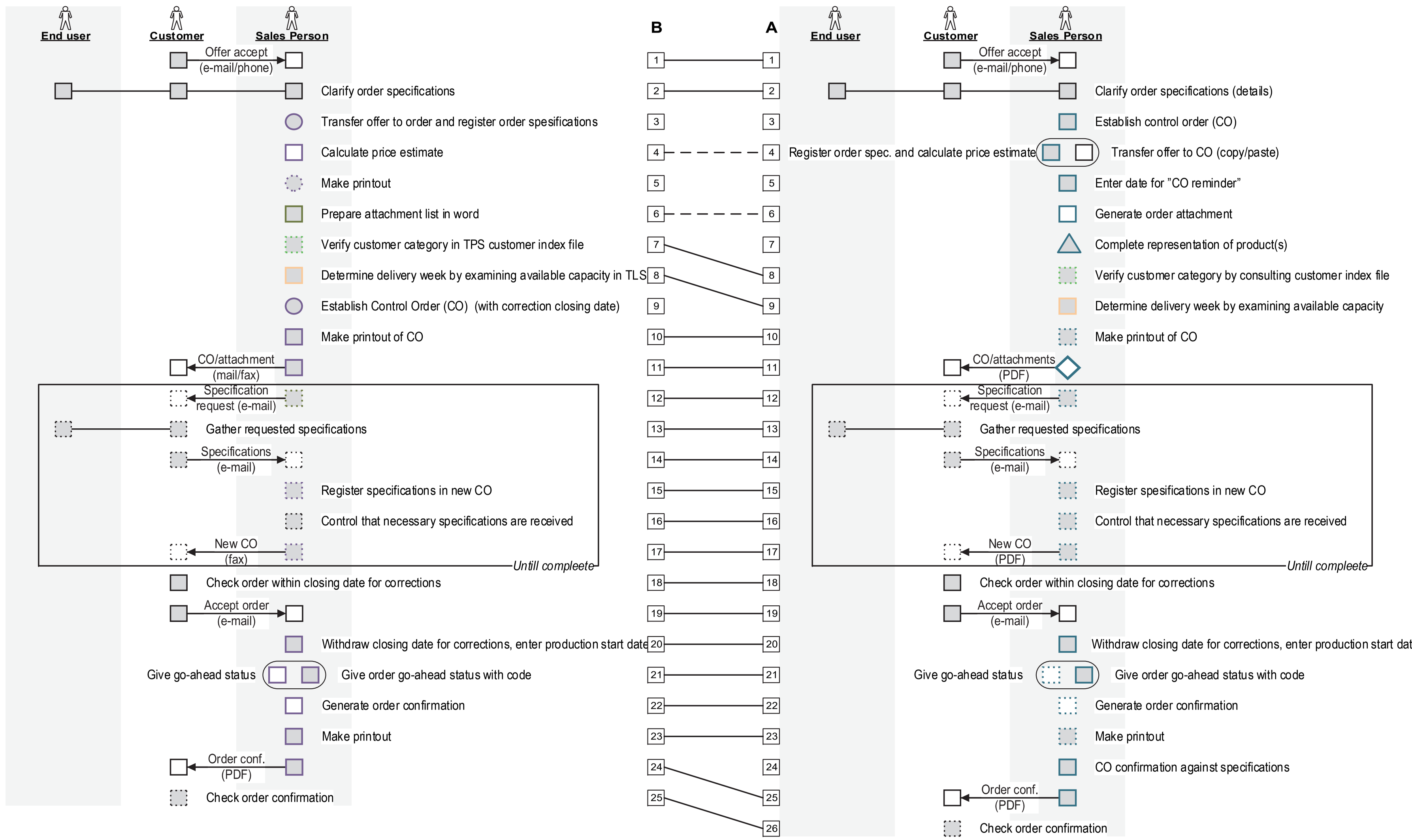

Figure IV. 20 Process model illustrating changes in the order registration process

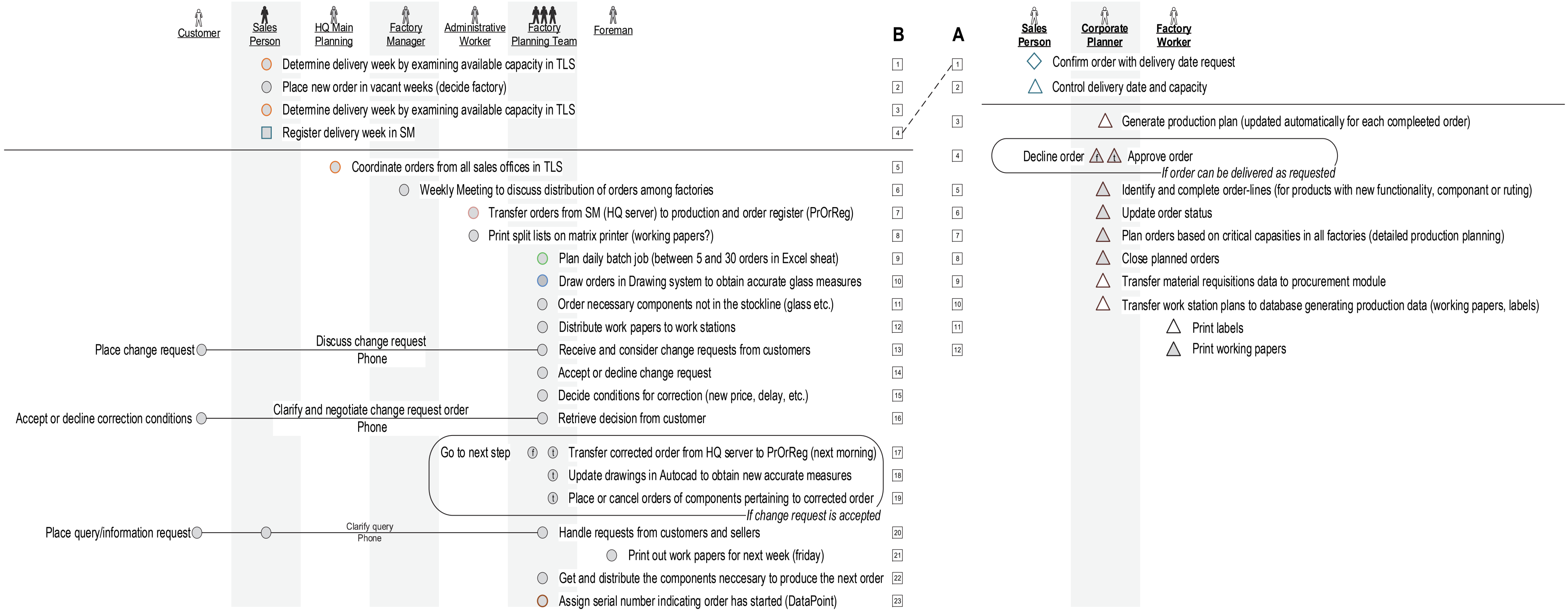

Figure IV. 21 Process model illustrating changes in the production planning process

NHH is one of the leading business schools in Scandinavia. Over 3,000 students study across a range of Bachelor, Master and PhD programmes.

NHH has a long reputation for its high academic level and contributions to the international research community. A large number of our faculty hold a PhD from institutions outside of Norway, in particular top US universities. This creates a diverse and stimulating academic environment.

The PhD student body is made up of around 100 men and women working within different fields of specialisation. The programme encourages close interaction between students and faculty in a social/academic climate where students are regarded as junior colleagues.

The PhD programme offers courses over a wide range of topics within six specialisations: Accounting; Economics; Finance; Management Science; Professional and Intercultural Communication; and Strategy and Management. The programme aims at giving the graduate a solid training in performing high quality scientific research in these areas, making use of state of the art empirical and theoretical techniques. This prepares the student for employment in national and international policy institutions, within research centres, business enterprises, and for the international academic job market. The entire programme is held in English. It runs over three years, with the first year consisting primarily of course work. The next two years are then devoted to independent research and the writing of a doctoral thesis, under the supervision of an advisor appointed from the NHH faculty.

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