Enterprise Modeling to Support ICT-Enabled Process Change

Context for and consequences of enterprise modeling in initiatives that combine process change and information and communication technology

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Summary of the thesis

This thesis presents findings from a multiple case study of enterprise modeling use in initiatives that combine process change and information and communication technology.

The study covers initiatives where models are made and used by people as part of a process change process, and an initiative where models are made as input to a business support environment enabling process change in the long run.

The research project was motivated by lack of empirical research on enterprise modeling practice and a wish to examine the relevance of the conceptualizations of the Process Modeling Practice model by Eikebrokk, Iden, Olsen and Opdahl (2006) into the wider enterprise modeling setting.

The overall research question was formulated as: *“How is enterprise modeling used and how can it be used to support information and communication enabled process change in Norwegian companies? Context for and consequences of enterprise modeling”*

To help focus the research project, the enterprise modeling practice model was developed. The model was built-up by categories from the Process Modeling Practice model (Eikebrokk et al, 2006) and findings from a pilot and a literature study. To make clear the study objective, an explicit research goal was set:

“to validate and elaborate the Enterprise Modeling Practice research model”.

Cases were compared by looking for patterns of relationships among constructs within and across cases.

The main multiple case research outcomes were:

(1) The identification of five different types of modeling initiatives by analyzing how each case combined use of information technology, process change main focus and the main objectives of modeling (Karlsen and Opdahl, 2012a),

(2) The identification of a broad variety of enterprise modeling benefits (Karlsen and Opdahl, 2012a),

(3) The identification of barriers to modeling, and findings indicating that the distribution of modeling maturity between project stakeholders affects how the modeling activities are carried out (Karlsen, 2011),

(4) A broadly validated and elaborated Enterprise Modeling Practice model (Karlsen, 2008; Karlsen and Opdahl, 2012b).

One of the cases was additionally investigated as a single-case study from a longitudinal perspective. This led to the additional research outcomes:

(5) A variety of modeling experiences and recommendations contributing to increased understanding of modeling practice.

(6) Description of how change happened, at an overarching level, in three stages: (1) Change maturation, (2) Change decision and (3) Process change, where the last stage constituted four steps of modeling supported process change: (1) Increased business understanding by providing a generic model, (2) Identification of TO-BE by process modeling, (3) Process categorization by sorting models into risk zones and (4) Implementation of prioritized change consistent with model artifacts.

(7) Identification of Readiness as a precondition both for change and for modeling.

Sammendrag av avhandlingen (Norwegian translation)

Avhandlingen presenterer funn fra en multippel case-studie av virksomhets-modelleringspraksis. Fokus er initiativer som kombinerer prosessendring med informasjons- og kommunikasjonsteknologi.

Både initiativ hvor modellene er laget og brukt av folk som del av en prosessendringsprosess og et initiativ hvor modellene er laget som input til et forretningsstøttesystem for prosessendring i det lange løp, inngår i studien.

Motivasjonen for forskningsprosjektet var manglende forskning på modelleringspraksis. I tillegg var studien motivert ut i fra et ønske om å få undersøkt og utviklet konseptualiseringene fra *the Process Modeling Practice model*, utviklet av Eikebrokk, Iden, Olsen og Opdahl (2006), i en annen setting.

Det overordnede forskningsspørsmålet ble formulert som: "*Hvordan brukes virksomhetsmodellering og hvordan kan virksomhetsmodellering brukes som støtte i initiativer som kombinerer prosessendring med informasjons- og kommunikasjonsteknologi i norske bedrifter? Kontekst og konsekvenser av virksomhetsmodellering*".

For å fokusere forskningsprosjektet ble en forskningsmodell utviklet. Modellen bygde på kategoriene fra prosessmodelleringspraksismodellen, the Process Modeling Practice model (Eikebrokk et al, 2006) og funn fra en pilot og en litteraturstudie. For å klargjøre målet med prosjektet, ble et eksplisitt forskningsmål formulert: "å validere og utvikle den initielle forskningsmodellen".

Casene ble sammenliknet ved å se etter mønster i sammenhenger mellom konstrukt innen og imellom case.

Forskningens hovedresultat knyttet til den multiple case studien er:

(1) Identifiseringen av fem forskjellige typer modelleringsinitiativ gjennom å ha analysert hvordan hvert case kombinerte informasjons- og kommunikasjonsteknologi, hovedfokus for prosessending og hovedhensikt med modelleringen (Karlsen and Opdahl, 2012a),

(2) Identifiseringen av en rekke fordeler knyttet til det å virksomhetsmodellere (Karlsen and Opdahl, 2012a)

(3) Identifiseringen av modelleringsbarrierer sammen med funn som indikerer at distribusjonen av modelleringsmodenhet mellom prosjektdeltakere påvirker hvordan modelleringsaktivitetene utføres (Karlsen, 2011)

(4) En validert og utviklet model av virksomhetsmodelleringspraksis, the Enterprise Modeling Practice model (Karlsen, 2008; Karlsen and Opdahl, 2012b).

I tillegg ble ett av casene studert for seg, ut i fra et longitudinelt perspektiv. Dette førte til følgende tilleggsresultat:

(5) En rekke modelleringserfaringer og modelleringsanbefalinger for økt forståelse av modelleringspraksis.

(6) Beskrivelse av endring som tre stadier: (1) Endringsmodning, (2) Endringsbeslutning og (3) Prosess endring, hvor det siste stadiet bestod av fire trinn som var støttet av modelleringsarbeid: (1) Økt forretningsforståelse gjennom bruk av en generisk modell, (2) Identifisering av TO-BE gjennom prosessmodellering, (3) Prosesskategorisering ved å sortere modeller inn i risikosoner og (4) Implementering av prioriterte endringer konsistent med modellutformingene.

(7) Identifisering av *Readiness* som en forutsetning både for endring og for modelleringsarbeid.

Content

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List of publications

During the research process the author has authored or co-authored five papers which comprise the main material of this thesis:

1. Karlsen, A (2008): A Research Model for Enterprise Modeling in ICT-enabled Process Change. In J. Stirna, A. Persson (Eds.): The Practice of Enterprise modeling, Lecture Notes in Business Information Processing, 1, Volume 15, Part 6, Springer, Pages: 217-230.

2. Karlsen, A., Opdahl, A. L. (2012a): Benefits of different types of enterprise modeling initiatives in ICT-enabled process change. International Journal of Information System Modeling and Design, Issue 3(3).

3. Karlsen, A. (2011): Enterprise Modeling Practice in ICT-enabled Process change. In P. Johannesson, J. Krogstie, A.L. Opdahl (Eds.): The Practice of Enterprise Modeling, Lecture Notes in Business Information Processing, 92, Springer, Pages: 208-222.

4. Karlsen, A., Opdahl, A.L. (2012b): Enterprise modeling in initiatives that combine process change and information and communication technology. Manuscript submitted for publication.

5. Karlsen, A., Opdahl, A.L. (2012c): Enterprise modeling practice in a turn-around project. Manuscript submitted for publication.

The papers are included in Appendix B, in the same order as they were submitted for publication. As regards printing and copyright, please note:

An electronic version of the paper "A research Model for Enterprise Modeling in ICT-enabled Process change", published in Karlsen (2008), can be downloaded from: http://www.springerlink.com/content/w172jpn07pl18077/

An electronic version of the paper "Enterprise Modeling Practice in ICT-enabled Process change", published in Karlsen (2011) can be downloaded from: http://www.springerlink.com/content/m16339037174t151/

The two manuscripts:

Karlsen, A., Opdahl, A.L. (2012b): Enterprise modeling in initiatives that combine process change and information and communication technology.

Karlsen, A., Opdahl, A.L. (2012c): Enterprise modeling practice in a turn-around project.

1. Introduction

1.1 ICT-enabled process change

Already in 1990, Hammer stated that we see both localized exploitation and internal integration of information and communication technology (ICT), together with business process redesign, business network redesign and business scope redefinition. He summarized the consequences of ICT on the design of processes as: (1) elimination of human work from the structured process through automation, (2) change of the sequence of activities and simultaneous working, (3) gathering of process information, (4) integration of tasks leading to the coordination of parts and tasks, (5) object orientation with the effect of tracking the status of process and work, (6) optimized analysis increasing the possibilities of analyzing information and decision making, (7) elimination of interfaces with the effect of reducing critical interdependences in processes and (8) the conquering of geographic distances leading to wide area coordination of processes (Hammer, 1990; Seidlmeier, 2004). Hammer and Champy (2006) described the interconnectedness between information technology (IT) and processes as a symbiotic relationship.

Difficulties are encountered both in the ICT industry and in and between enterprises implementing new ICT systems to facilitate processes (The Royal Academy of Engineering, 2004). It is claimed that most implementation failures are related to insufficient alignment between various parts of an organization and the new technology (Wognum, 2004) and that difficulties can be related to the increase in business complexity (Kaplan and Norton, 2005). An example is found in McAfee (2006, p. 142):

"*Managers I've worked with admit privately that success with ICT requires their commitment, but they're not clear where, when, and how they should get involved. That's partly because executives usually operate without a comprehensive model of* *what ICT does for companies, how it can affect organizations, and what managers must do to ensure that ICT initiatives succeed"*

While ICT system implementation processes are often handled as technical endeavors, they should rather be regarded as organizational change (Davenport, 2000). On the other hand, calling it a mere process change project, or alternatively business change project, indicates an over-dependent focus on process or business aspects (Manwani, 2008). In compliance to such reflections the term "initiatives that combine process change and information and communication technology" is preferred in our work to highlight both the technological and the organizational aspects associated with implementing ICT to enable process change. In this circumstance Enterprise Resource Planning Systems (ERP), or "Standard Business Application Software" which is the preferred term in continental Europe (Klaus, Rosemann and Gable, 2000), is a specific type of package application software associated with several of the combined ICT and process change initiatives under study. ERP systems are well-known to enable process change. The purchase of such application software has since 1990 for many firms been the preferred ICT strategy, instead of developing information systems in-house (Hong and Kim, 2002). According to Klaus et al. (2000) these software solutions seek to integrate the complete range of business's processes and functions, to present a holistic view of the business from a single ICT and information architecture application. The ERP concept can be viewed from a variety of perspectives: (1) ERP is a commodity in the form of computer software, (2) ERP can be seen as a development objective of mapping all processes and data of an enterprise into a comprehensive integrative structure and (3) ERP can be seen as the key element of an infrastructure that delivers a solution to a business (Klaus et al, 2000). A range of general commercial ERP software packages are offered on the marked. Some solutions are generic and support multiple industries within several industries, whereas others are branch specific ERP solutions. In general ERP software is a standard software package, and all standard packages targeting an anonymous market must be tailored to the specific requirements of the individual enterprise during the process of system deployment by customizing it by the help of preconfigured alternatives built into the application (Klaus et al., 2000). Klaus et al (2000) points to Scheer and Habermann (2000) highlighting the significance of business process models to manage the ever-increasing complexity arising from the solutions, and that process models are supposedly also a useful medium to communicate about business processes across cultures. Hong and Kim (2002) found that organizational fit of ERP is critical in explaining ERP implementation success, and that both ERP and process adaption interact with organizational fit of ERP on ERP implementation success. They also found that process adaption may be a safer choice than ERP adaption when organizational fit of ERP is low. Hong and Kim (2002) concluded that for successful ERP implementation, both ERP implementation managers and top management should be able to assess the fit between their organization and the target ERP system before its adoption, and once adoption is decided should measure and manage the impact of ERP and process adaption from a risk assessment approach as suggested in Brehm , Heinzl and Markus (2001), to minimize potential business disruptions and user resistance.

Another type of package application software being associated with our cases is a quality management system. The system is described by the ICT-vendor as a system to let you view your organization via visualized process models and other perspectives; "*developed to support and facilitate the creative desire and ability to change. By doing so it contributes actively to encourage businesses and organizations to improve continuously*". [Material from IT-vendor, C7].

The third type of package application software associated with our cases is a wearable voice-directed warehouse application system, e.g. a system where workers give and receive voice commands as they select orders and replenished stock in a warehouse building. The system provides audio commands directing users what to do, with speech recognition technology that understands a user's spoken responses. The system integrates with other warehouse systems and increases productivity and accuracy across the picking process and related tasks (Adams, 2010).

1.2 Enterprise Modeling

Enterprise modeling is the process of understanding a complex social organization by developing models (Rumbaugh, 1993), and is a key tool in knowing business processes as a prerequisite for improvement (Andersen, 2000), used as a tool in discussion and understanding in business change programs (White and Miers, 2008). Enterprise modeling supports the strategic alignment task as well as the management of planning progress and change of business systems and practices (Loucopoulus and Kavakli, 1995).

Change involving the implementation of new ICT solutions is more the rule than the exception in enterprises of these days (Kock, 2007). An example of a well-known obstacle in such change projects is the capability to find a good match between the business processes and the ICT-solution. The conventional strategy to information systems development has proved to be too monolithic and lacking features for dealing with highly complicated, multi-dimensional systems. In the traditional paradigm little is done to understand how system components relate, or the effect an information system has on the enterprise itself (Loucopoulus and Kavakli, 1995). In such a situation enterprise modeling can be used to improve the project participants' understanding. During the course of the process change process, project participants will know how to best align the ICT-solution to the business processes or vice versa (Loucopoulus and Kavakli, 1995). There is a need for adaption and alignment of organization and technology both during and after the implementation process (Kenett and Lombardo, 2007; Markus and Tanis, 2000; Orlikowski, 1992; Leonard-Barton 1988).

Enterprise modeling is often used as a catch-all title (Fraser, 1994), and it is a term covering the set of activities, methods and tools related to develop models of various aspects of an enterprise (CEN, 1994; AMICE, 1993; Petrie, 1992). It can be defined as a symbolic manifestation of the enterprise and the things that it deals with, containing representations of individual facts, objects, and relationships that occur within the enterprise (Presley, Huff and Liles, 1993). Enterprise modeling provides the means for describing the current structure of the enterprise, its missions and goals and can also be used as a thinking device for assessing the consequences of the applied technology and the business redefinition in the enterprise (Loucopoulus and Kavakli, 1995). An enterprise model is an assemblage of models Vernadat (2004) explains, and defines enterprise modeling as the set of actions or processes used to create the various parts of an enterprise model to address some modeling finality.

In general there is little consensus on how enterprise models and enterprise modeling are and should be defined (Aranow, 1991). Gustas (2005) for example states that the term enterprise model is another name of enterprise architecture.

Persson (2001) describes the usefulness of enterprise modeling in information systems development, especially in the requirement stage of the development process. Loucopulus and Kavakli (1995) recommend enterprise modeling to assist a requirements engineer to proceed from ill-defined requirements to well-defined ones, based on the picture of the universe of discourse and its operation, provided via the models made.

However, individuals need not be the only consumers of enterprise models. Enterprise modeling can also be used to fill for example a quality system with content. In this situation benefits of enterprise modeling are especially linked to the sharing of artifacts produced via a common reservoir of models accessible throughout the organization. In this way a consistent work manner for all employees is supported. Due to such examples it is obvious that enterprise modeling generate both intangible and tangible outcomes that can be valuable both in short-term and long-term process change endeavors.

Vernadat (1996) postulated that an enterprise model already exists in any company but that the model often is little formalized and exists in the form of organization charts established by management, recorded operational procedures, regulation texts, and in the amount of enterprise data. He stated that a large part of the enterprise model remains in the minds of the company's staff without any formalization or documentation. He therefore recommended methods and tools to capture, formalize, sustain and use this knowledge for better process management.

A great number of commercial tools have come on the market these days to assist with architecture visualization and modeling (Nightingale and Rhodes, 2004). Enterprise architecture visualizations include the use of software tools and advanced modeling techniques to create a visual and adaptable model of an enterprise. As the complexness of the enterprise develops, so should the need for modeling and visualization tools and methods grow (Nightingale and Rhodes, 2004).

Table 1 has been developed to illustrate dimensions of the enterprise modeling field, based on Whitman et al. (2001). New architectures, frameworks, tools and approaches are developed at a steady rate.

Enterprise modelling architectures and frameworks	Tools	Enterprise Modeling Approaches
ARIS CEN ENV 40 003 CIMOSA Enterprise architecture framework GERAM GRAI/GIM IAA ISA ISO work on enterprise modelling frameworks PERA TOGAF Zachman	AI0 WIN ARIS Toolset ARIS Easy Design ARIS for R/3 Artifex BONAPART CIM CAMT EMS ExSpect First Step Flow Mark IMAGIM METIS MO^{2}GO PACE PROPLAN ProSim/ProCap QUEST SEW-OSA SmartClass SmartCost SmartER WITNESS Workflow Modeler Workflow Simulator	Entity-relationship method EXPRESS Flowcharts IDEF0 IDEF1 IDEF1x IDEF3 IDEF4 IDEF5 IEM OMT OOA ORM/NIAM Petri Nets SADT SA/RT TOVE

Table 1: Enterprise modeling overview

2. Theory

Motivated by the fact that comprehensive research initiatives have been spent on the development of enterprise modeling languages, architectures frameworks and tools, while significantly less effort has been dedicated to obtain knowledge about enterprise modeling practice, Persson (2001) developed a grounded framework of situational factors that affect the applicability and application of participative enterprise modeling, together with a theory on how the factors affect each other.

Persson and Stirna (2002) reported from two individual enterprise modeling case studies. One targeted ways of working, and the other tool support. They conducted company observations and a total of 22 interviews. One conclusion from their studies was that participative enterprise modeling should only be used in consensus oriented organizational cultures. If properly applied it is a very powerful way of committing stakeholders to business decisions.

Delen and Benjamin (2003) provided an analysis of the significant hurdles to a broader use of enterprise modeling and analysis methods. They also provided a methodical approach and a software implementation that addressed them. They found that the main reason for restricted success of enterprise modeling and analysis methods in industry is complex methods which require acute expertise to be used effectively. Delen and Benjamin (2003) stated that the models used technical jargon hardly understandable to the non-initiated. They presented several features of modeling and analysis efforts: (1) Enterprise analysis efforts are analyst-dependent, (2) Enterprise analysis includes time- and communication intensive actions, (3) A significant amount of the effort spent is not reusable in the sense that knowledge transferred from domain experts to an analyst is seldom possible to reuse in other analysis efforts of another nature and (4) Decision-makers are not in control of the analysis attempt. The scientists saw these features of the modeling and analysis efforts as obstacles in need of tools and methods to increase enterprise analysis methods use.

To overcome the obstacles, they recommended the development of a truly integrated modeling environment, Model Mosaic.

Sedera, Gable, Rosemann and Smyth (2004) did an empirical case study into key factors of effective process modeling and post-hoc assessment of process modeling success. Based on their findings, they developed a Success Model for business process modeling. In Bandara and Rosemann (2005) findings from a detailed case study performed at a leading Australian company is presented which contribute to the build-up of this model.

Eikebrokk, Iden, Olsen and Opdahl (2006) studied Norwegian model-supported process-change practice. They presented both an a priori Process Modeling Practice model and a revised model. The a priori model indicated that characteristics of the organization influence the process modeling process. The model also showed that modeling purpose and artifacts available influence the modeling process. They suggested that process modeling has a result that affect the organization as a whole, in the form of eventual process and modeling maturity. For short, their analyses indicated that the combination of technological, social and organizational factors explain the outcome of model-based process change projects.

Recker, Indulska, Rosemann and Green (2006) provided an analysis of Business Process Modeling Notation (BPMN). They performed a representational analysis of BPMN using a representation model based on the Bunge ontology. In addition to theoretical recognition of possible limitations of BPMN, they compounded their propositions with empirical evidence. In general they offered understanding both into theoretical capabilities of this specific type of notation, and actual perceived shortcomings. More particularly they identified critical issues related to the practice of modeling with BPMN in modern process management initiatives. In Recker et al. (2010) they outlined the need for concerns of representational issues and contextual factors in decisions regarding BPMN adoption in organizations.

Stirna, Persson and Sandkuhl (2007) used a conceptual and argumentative research approach and reported a set of general encounters from applying participative enterprise modeling in different business situations. They mainly focused on three cases, but emphasized that they had successfully used the approach in many other organizations. Among the recommendations of using participative enterprise modeling in practice the reader find that having confidence from the relevant decision-makers is especially critical for participative enterprise modeling project managers, when it comes to acquiring enough effort from domain experts. Stirna et al (2007) stated that a participative approach is only appropriate in consensus-oriented organizations and that in authoritative cultures it is extremely difficult to obtain consensus-driven participation in the enterprise modeling groups. Further on, they highlighted that hidden agendas can be part of a project, and that the whole project itself can be a hidden agenda, whereby the latter situation is the most fatal one. They also stated that hidden agendas will reduce the possibility of reaching the project goals since different stakeholders will focus on steering the project towards their own goals. Concerning assignment of roles in the enterprise modeling process they recommended that one assign the typical roles in project management, e.g. project owner, steering group, quality manager and the following roles specifically related to participative enterprise modeling projects: (1) The modeling facilitator, (2) The tool operator and (3) The modeling participants, also called domain experts. The domain experts are responsible for providing correct knowledge about the problem domain and to make sure that this is reflected in the model, and function as the problem solvers. Stirna et al. (2007) considered an array of issues to be essential for the quality of outcome of an enterprise modeling session, for example the need to set clear objectives of practical value to the organization in relation to each enterprise modeling session and not to train the modeling participants in method knowledge, since too much attention to the method/notation used will distract the modeling participants from fixing the issue at hand.

Glassey (2008) compared three process modeling techniques, Adonis, OSSAD and UML, in order to find common concepts and significant differences. He concluded that the techniques are equivalent and can be used indifferently at the operational level. At the structural level the choice of technique are dependent on the domain to be modeled.

Mendling (2008) investigated metrics for business process models and suggested the need for suitable measurements. He highlighted that in a growing discipline like complexity of business process models it might not be clear what to measure in the first place. Suggesting and talking about measures however, reveals a controversy that eventually causes greater understanding.

Dreiling, Rosemann, Sadiq and Van Der Aalst (2008) proposed a method aiming at increasing the efficiency of enterprise system implementations, and discussed a concrete example involving three modeling techniques. They suggested that current modeling languages feature various degrees of abstraction for different users and different purposes making it necessary to integrate them. According to the writers conceptual modeling is underutilized in the context of enterprise systems configuration, and because of this the question appears as to how to create improved value proposition related to conceptual modeling as part of a project. They also posted that modeling is often seen as a device for documentation purposes only, and therefore not seen as a value-adding tool within an enterprise systems project.

Through a multi-methods study of eighteen business process redesign projects in eighteen organizations Kock, Verville, Danesh-Pajou and DeLuca (2009) found that focus on communications flows in business processes is important in successful business process redesign projects. They emphasized that business process redesign has been intensely examined since the nineties, but that little attention has been paid to the relationship between business process alternatives and redesign success.

Sandkuhl (2010) examined use of modeling to catch organizational knowledge for helping product development with task patterns, and assessment of task pattern use with a focus on economic effects acquired. His results were based on work in the EU-FP6 project MAPPER (Model-adapted Process and Product Engineering) where analysis of requirements for collaborative engineering support, development of a collaboration infrastructure, and application of the infrastructure in daily work were performed in an industrial case taken from automotive industries. He concluded that the industrial application of task patterns proved both feasible and deployable and led to a number of positive evaluation results; reduction of lead times, improved quality of product documentation, and enhanced quality of best practices when using knowledge models instead of conventional documentation.

Davies, Green, Rosemann, Indulska and Gallo (2006) investigated conceptual modeling practice via a web-based survey among members of the Australian Computer Society. They discovered that the highest ranked purposes for modeling were database design and management, business process documentation, business process improvement, and software development. They also found that the top six most frequently applied techniques and methods were ER diagramming, data flow diagramming, systems flowcharting, workflow modeling, UML, and structured charts. Additionally they found that in small organizations database design, management and software development are primary purposes for modeling. In larger organizations (larger than 50 employees) business process documentation and business process improvement are more critical purposes for modeling. An essential contribution of the study was the recognition of factors that uniquely effect the continued-use decision of analysts, viz., communication to/from stakeholders, internal knowledge (lack of) of techniques, user expectations management, understanding models integration into business and tool/software deficiencies.

3. THE AIMS OF THE STUDY

3.1 The overall research question

Inspired by lack of empirical research on enterprise modeling use, this study was initiated to obtain empirical evidence on enterprise modeling practice of interest to anyone involved in practical ICT-enabled process change.

The study was also motivated by a project where a Process Modeling Practice model (Eikebrokk et al., 2006) had been developed. My supervisor had been involved in this work and saw it valuable to have the model's conceptualizations examined into the wider enterprise modeling setting.

The specific focus on ICT had a clear personal motivation. This was attached to my work as an Assistant professor at Aalesund University College in information systems development. It was suggested that the findings would be valuable in the teaching process where most material so far focused on academic literature from abroad due to lack of nationwide and local cases. Having a focus on practice was also potentially valuable to my employer who focuses on offering candidates within the engineering disciplines where the practice focus is high.

To deal with the motivational aspects, the overall research question was at first stated as: "How is enterprise modeling used and how can it be used as a technique for ICT-enabled process change in Norwegian West Coast enterprises? Context for and consequences of enterprise modeling."

With no initial knowledge of the enterprises that became objects of our study, we made a choice to use the term enterprise modeling in a broad sense to capture how the companies actually use enterprise modeling; possibly by using both formalized and non-formalized languages and tools in the initiatives under study that combined process change and ICT. As described in the data collection section, the research question was later on modified to the following statement:

> *"How is enterprise modeling used, and how can it be used to support ICT-enabled process change in Norwegian companies? Context for and consequences of enterprise modeling."*

3.2 The research goal

It is not possible to engage in research without an idea of what one is looking for, and it is also foolish not to make that quest explicit (Wolcott, 1982). With this saying in mind, and with an objective to investigate and develop the conceptualizations of the Process Modeling Practice model, the Enterprise Modeling Practice research model was developed, incorporating the categories of the Process Modeling Practice model (Eikebrokk et al., 2006). Other categories were found via literature studies and a pilot study.

The Enterprise Modeling Practice research model, figure 1, was presented in Karlsen (2008) and was built-up of three main categories: <u>Enterprise Modeling</u> , <u>Context</u> and <u>Outcome</u>, where each category constituted various sub-categories.

<u>Enterprise Modeling</u> (EM)) was defined as "*the set of activities or processes used to develop the various parts of an enterprise model to address some modeling finality*" and constituted the sub-categories (Karlsen, 2008, p. 224): (1) <u>Management support</u>, defined as "*the level of commitment by management in the organization to the modeling projects, in terms of their own involvement and their allocation of valuable resources*", (2) <u>Modeling guidelines</u>, defined as "*a detailed set of instructions that describes and guides the process of modeling*", (3) <u>Modeling tools</u>, defined as "*software that facilitates the design, maintenance and distribution of models*", (4) <u>Individual modeling or workshop</u>, defined as "*to what extent enterprise modeling is*

done as a team-work or on an individual basis", (5) Participation and involvement, defined as "*the degree of input from stakeholders, for the design and approval of the models*", (6) Resistance, defined as "*a state of mind reflecting unwillingness or unreceptiveness*", (7) Modeling languages, defined as "*the grammar or the syntactic rules of the selected modeling techniques*" and (8) Model artifact, defined as "*a man-made representation of part of an enterprise, for example a process*".

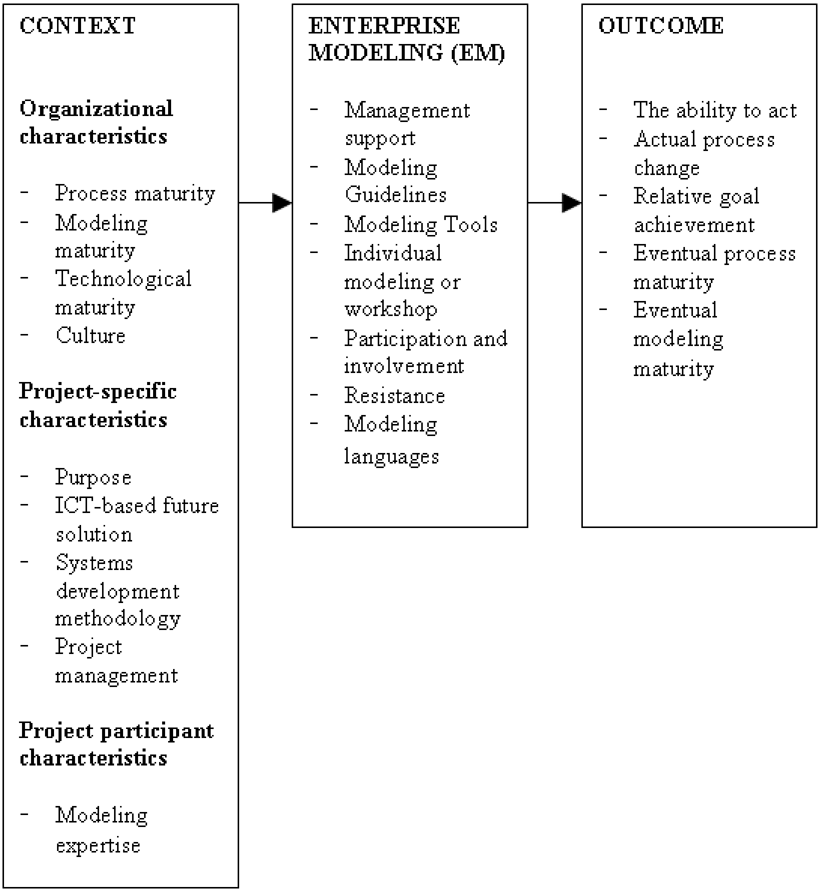

Fig. 1. The Enterprise Modeling Practice research model (Karlsen, 2008)

Context was defined as the setting of the project comprising Organizational characteristics, Project participant characteristics and Project specific characteristics, where (1) Organizational characteristics was defined as (Karlsen, 2008, p. 223-224): "*a collective term of those organizational categories that might influence the modeling process*", (2) Project-specific characteristics was defined as "*a collective term of those categories specific to the project that possibly influence the modeling process*" and (3) Project-participant characteristics was defined as "*characteristics of those involved in the ICT-enabled process change project.*"

Organizational characteristics constituted the subcategories (Karlsen, 2008, p. 226): (1) Process maturity, defined as "*an organization's capability for process management and operation, including available competence and current practice*", (2) Modeling maturity, defined as "*an organization's capability for enterprise modeling, including available competence and current practice*", (3) Technological maturity, defined as "*an organization's capability within the field of ICT; knowledge of existing solutions and knowledge of possible future or other enterprises solutions*" and (4) Culture, defined as "*the organization's readiness to accept and participate in a modeling initiative*".

Project-specific characteristics constituted the subcategories (Karlsen, 2008, p. 226): (1) Purpose, defined as "*the purpose of the ICT-enabled process change project*", (2) ICT-based future solution, defined as "*a mean to enable process change*", (3) Systems development methodology, defined as "*a standard process followed in an organization to conduct all the steps necessary to analyze, design, implement and maintain information systems*", (4) Project management, defined as "*a controlled process of initiating, planning executing and closing down a project*" and (5) Resources, defined as "*available time, money and people to initiate, plan, execute and close down a project*".

Project-participant characteristics constituted the subcategory Modeling expertise, defined as "*the experiences of the project participants in terms of conceptual modeling in general*" (Karlsen, 2008, p. 225).

Outcome was defined as "*the phenomena that follow and are caused by enterprise modeling, including attainment of purpose and the effect of enterprise modeling on the ICT-enabled process change solution*", and constituted the subcategories (Karlsen, 2008, p. 225): (1) Ability to act, defined as "*knowledge; ones capacity to set something in motion*", (2) Actual process change, defined as "*the effect of enterprise modeling on processes*", (3) Relative goal achievement, defined as "*the result of the project seen in accordance with overall business objectives*", (4) Eventual process maturity defined as "*changes in an organization's capability for process management and operation*" and (5) Eventual modeling maturity, defined as "*changes in an organization's capability for enterprise modeling including available competence and current practice after the modeling process*".

"Sound empirical research begins with strong grounding in related literature, identifies a research gap, and proposes research questions that address the gap." (Eisenhardt and Graebner, 2007, pp.26)

Through these categories and their corresponding sub-categories, the Enterprise Modeling Practice research model expressed our initial research propositions on enterprise modeling practice (Karlsen, 2008; Karlsen and Opdahl, 2012 a):

> *(1) Modeling maturity, Process maturity, Technological maturity and Culture of the organizations influence Enterprise modeling*

Modeling maturity was expected to influence modeling practice due to research by Eikebrokk et al (2006) suggesting this relationship in their study on process modeling practice.

Technological maturity was expected to imply possible restrictions on process design, motivated by Davenport (1993) suggesting this relationship.

Process maturity was expected to influence Enterprise modeling, motivated by Eikebrokk et al (2006) suggesting this relationship.

Culture was singled out as a possible relevant category suggesting that organizations with more organizational readiness to accept and participate in modeling initiatives are likely to be more successful in process modeling projects (Sedera et al., 2004).

(2) Modeling expertise of project participants affects Enterprise modeling.

Modeling expertise: was singled out as a possible relevant category due to Sedera et al.(2004) finding that organizations with more modeling experience are likely to be more successful in process modeling projects.

(3) *Purpose, ICT-based future solution, Systems development methodology, Project management and Resources influence Enterprise modeling.*

Purpose was expected to influence whether modeling was used to support ICT-enabled process change or not, based on findings from the pilot study. The category was also motivated by the Process Modeling Practice study by Eikebrokk et al. (2008) suggesting that purpose influences modeling practice.

Knowledge of ICT-based future solution was expected to influence how processes were shaped (Davenport,1993). In addition Hammer and Champy (1993) described the interconnectedness between information technology and processes as a symbiotic relationship.

Systems development methodology chosen was expected to dictate extent of model making as part of ICT-enabled process change, motivated by the pilot study.

Project management was singled out as a possible relevant category since project management was the most cited success factor in relation to process modeling in Sedera et al. (2004).

Lack of project Resources was expected to lead to reduced use of enterprise modeling as part of ICT-enabled process change, motivated by findings from the pilot study.

(4) Individual modeling or workshop in Enterprise modeling contributes to Eventual process maturity.

Individual modeling or workshop: was motivated by Eikebrokk et al. (2008) who concluded that individual modeling or workshop is positively correlated with eventual process maturity.

(5) Participation and involvement, Management support, use of Modeling guidelines, Modeling tools and Model artifacts in Enterprise Modeling contribute to modeling Outcome.

Participation and involvement was motivated by Eikebrokk et al. (2008) who via quantitative analyses found that participation and involvement is correlated with outcome and Sedera et al. (2004) who concluded that participation and involvement is a process modeling success factor.

Management support was motivated by Sedera et al. (2004), and Davenport (1993) seeing it as vital for success that management is involved and allocate necessary resources. In addition findings from the Process Modeling Practice study by Eikebrokk et al. (2008) showed that management support is significantly and positively correlated with outcome.

Use of Modeling guidelines and Modeling tools was included in the model due to indications of their overall relative importance within a process modeling project, Sedera et al. (2004).

(6) *Resistance in Enterprise modeling is related to Model artifact,* was motivated by Eikebrokk et al (2008).

(7) Modeling languages in Enterprise modeling affects Modeling guidelines.

Modeling languages was included due to indications of its importance within a process modeling project (Sedera et al, 2004). That Modeling languages potentially affects Modeling guidelines was motivated by findings showing modeling style significantly correlated with modeling framework (Eikebrokk et al., 2006).

(8) Enterprise modeling leads to increased Ability to act, Actual process change, Relative goal achievements, Eventual process maturity and Eventual modeling maturity.

Ability to act, in the sense of increased knowledge, was expected to be an important outcome of modeling (Bustard et al., 2000). The term *Ability to act* was motivated by Nico Stehr (2001) who described knowledge as increased ability to act in the sense of increased ability to make good decisions.

Actual process change**,** Eventual process maturity and Eventual modeling maturity were motivated by Eikebrokk et al. (2006) who found that modeling process has an outcome not only relevant for the process alone, but influences the organization as a whole in the form of eventual process maturity and modeling maturity.

Relative goal achievement was included in the model based on Davenport (1993) suggesting that projects lead to various outcomes and Eikebrokk et al's (2006) findings of eventual process maturity and eventual modeling maturity as modeling outcomes. It was suggested that other outcomes could be found also, so we chose the broader term *Relative goal achievement* to catch these instances.

A precise research goal is useful because it makes the purpose of a study clear (Wolcott, 1982; Miles and Huberman, 1994).

We defined as a research goal to validate and elaborate the Enterprise Modeling Practice research model.

By stating this research goal we implicitly would be able to examine the relevance of the Process Modeling Practice model's (Eikebrokk et al, 2006) conceptualizations into the wider enterprise modeling setting.

3.3 The research approach

A variety of research methods are available. What distinguishes one method from another is related to ontological and epistemological stances (Symon and Cassell, 2004). Choice of method might be pushed by particular concerns, for example quantitative studies driven by positivist concerns are basically adopting a conservative research strategy whilst qualitative approaches and research adopting alternative epistemological perspectives carry out the promise of new insights by adopting alternative epistemological practices and approaching research topics with different objectives (Symon and Cassell, 2004).

Due to an evaluation of the study's aims which was envisioned at a very early stage of the research process, we decided to conduct a multiple case study since a multiple case study is suitable when the objective is to examine a contemporary phenomenon in depth and within its real-life context, and when the boundary between phenomena and context are not clearly obvious (Yin, 1984, Yin, 2009). Key words in our decision process were "in-depth study", "how", "use", "in practice" and "elaboration". These keywords sifted our thoughts towards an empirical study in a limited number of enterprises. Another aspect, addressing the overarching research question, is that case studies are useful when studying 'why' and 'how' questions that cope with operational links to be traced over time rather than with frequency or incidence (Benbasat, Goldstein and Mead, 2002). Case study research is also the most common method used in IS research (Myers and Avison, 2002), and it has already been used within the enterprise modeling field and the related field of process modeling, for example by Persson and Stirna (2002) and by Bandara and Rosemann (2005), as shown in the theory section. In addition we chose to do semi-structured interviews supplemented by the collection of documents, model-prints and other material, see table 2 to table 4 for details. The rationale for using multiple sources of evidence was found in Yin (1994) stating that a major strength of case study data collection is the opportunity to use many different sources of evidence, e.g. data triangulation.

Case	Main organization	Number of employees	Interviewed*	Additional sources of evidence
C1	The construction industry, the House Builder	33	The owner and top manager A combined IT-vendor and consultant	• Board protocols • Mail correspondence on modelling meetings • Summary of the case history, written by the project manager • Note on what the project manager saw as challenges associated with the modelling process • Financial numbers • Letter and mail to the bank • Model artefacts • Literature references and other documents motivating the approach followed • Procedure descriptions • PowerPoint slides from business meetings • Description of the stages followed in the building process
C2	The marine sector, service provider to fish farmers	7	The manager The consultant The IT-vendor	• Decision document on choice of system • Project description • Letter correspondence to ICT-vendors • Implementation plan • Organizational chart/design • Process descriptions • Table of requirements

*Those interviewed where those persons our contacts recommended based on an evaluation of their involvement in the projects in general and in modelling activities in special

Table 2: Sources of evidence, case C1 and case C2

Case	Main organization	Number of employees	Interviewed*	Additional sources of evidence
C3	The maritime sector, product provider to the maritime industry	7	The top manager The combined IT-vendor and consultant	• Company information • PowerPoint slides used in the project • Model artefacts • CV of the project leader's competence
C4	The marine sector, laboratory service provider	7	The owner and top manager An employee An consultant	• Laboratory system requirements specification • CV of project manager • Model artefacts • Interface specification
C5	The off-shore sector, service provider	11	A consultant	• Work processes – mapping method description • Model artefacts/Process descriptions
C6	A wholesaler within the food sector, food distribution	125	A manager within the main organization The combined IT-vendor/consultant involved in the project	• PowerPoint describing the history of the project • Historical document on systems development and early model artefacts • Model artefacts associated with the new ICT system • Project schedule • Article on system • Implementation guide

*Those interviewed where those persons our contacts recommended based on an evaluation of their involvement in the projects in general and in modelling activities in special

Table 3: Sources of evidence, cases C3 to C6

Case	Main organization	Number of employees	Interviewed*	Additional sources of evidence
C7	The banking sector, bank services	1000+	The IT-vendor of the quality system The project manager A person with a central role in the specification of the quality system build-up A person involved in the modelling process from a specific department in the bank Another person from another department also involved in the modelling process An enterprise architect in the organization	• PowerPoint slides describing how projects are performed in the bank • Document describing the decision process, risks and economic concerns associated with choosing a new ICT system • Project description document • Model artefacts • Final quality system architecture report • Final report describing the choice of the process oriented business support system
C8	The maritime sector, ship building	N/A	A main representative from the IT-vendor Manager Manager	• Initial project description • Company descriptions • Model artefacts/process descriptions

*Those interviewed where those persons our contacts recommended based on an evaluation of their involvement in the projects in general and in modelling activities in special

Table 4: Sources of evidence, case C7 and case C8

We designed an interview guide related to the categories of our research model. In this way the Enterprise Modeling Practice research model focused data collection.

There are many time-consuming activities associated with doing case studies, for example gaining and maintaining access to organizations, collecting systematic data from a variety of sources and transcribing the material, where an hour of interviewing equals several hours of writing and analyzing (Hartley, 2004). The question of doing an additional quantitative study to increase our ability to make broad generalizations was discussed, but was left as an opportunity due to time and resource restrictions associated with our study.

Instead we expanded our study by gathering additional information in one of the cases, the Home Builder. This choice was inspired by Indulska et al (2009) calling for exploration and publication of success studies and King (2004) warning that individual participant's voices are in danger of being lost when comparing cases. In addition we had read that Brown and Eisenhardt (1998) added successful and unsuccessful turnaround cases to their investigation, enabling them to add further longitudinal elements to their theory (Eisenhardt and Graebner, 2007).

The case was exciting because latest economic results documented that the company had changed from facing risk of bankruptcy to become a viable market actor. Additional information was collected and the outcome was a paper describing change from a longitudinal perspective. The paper contributed to understanding of modeling use by reporting a set of modeling experiences and recommendations associated with four process change steps.

Methodological issues are further discussed in section 5.2.

3.4 Data collection

The qualitative research interview is a tool to get descriptions of the life-world of the interviewee with regard to interpretation of the meaning of the described phenomena (Kvale,1996). The qualitative research interview is not based on a formal schedule of questions to be asked word-for-word in a given order. Instead it often uses an interview guide, listing topics which the interviewer should cover in the course of the interview and suggesting probes which may be used to follow-up responses and elicit greater detail from participants (King, 2004). In our study we pre-formulated questions to make sure a certain level of quality in the on-the-run interview meetings adapting to the natural speech flow of the interviewees. The interview guide was supplemented by a list of the Enterprise Modeling Practice model's categories providing probes used in the interview situation. See Karlsen and Opdahl (2012a), Appendix B, for the interview guide.

The search for research material led to a study across eight cases. A case was defined as a constellation of (1) a main organization or (2) a consulting company and/or an IT-vendor. The main organizations of the cases were related to the construction industry (case C1), the marine sector (cases C2 and C4), the maritime sector (cases C3 and C8), the offshore sector (case C5) a wholesaler within the food sector (case C6) and the banking sector (case C7). Twenty-two informants were interviewed. In addition material was collected in the form of model prints, reports and historical material. Organizational information was additionally downloaded from the internet. We also visited the various companies and received demonstrations of the software solutions involved. The two managers that assisted us get hold of a relevant case in the first place, got the role as expert informants in the investigation. They were visited several times, and offered information of the practice field by sharing their thoughts at an overall level. See Karlsen and Opdahl (2012a), Appendix B, for supplemental case information.

3.5 Analysis

We used *Qualitative analysis: An Expanded Sourcebook* by Miles and Huberman (1994) to guide our analyses. This book gives a thorough description of coding as analysis, where coding is described as tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. In addition we found King (2004) highly relevant on template analysis. We used template analysis to arrange and analyze our 500 pages of transcribed text and other kind of textual data. The essence of template analysis is that the researcher produces a list of codes (‘template’) representing themes identified in their textual data. Some of these will usually be defined a priori, but will be modified and added to as the researcher reads and interprets the text. The template is structured in a way that represents the relationships between themes, as defined by the researcher, most commonly including a hierarchical structure (King, 2004).

The research model defined our a priori codes. To link segments of text to particular themes, to link various sources to coding and to carry out complex search and retrieve operations, we used the software package Nvivo as a template analysis tool. Nvivo is a program that lets users classify, sort and organize information, examine relationships in the data and combine analysis with linking, shaping, searching and modeling. The program provides database features useful on large data samples and keeps track of information that is related to the same subject matter. By clicking on a node, sources coded at that particular node are opened. Each node can be associated with references to multiple sources.

We started by developing our initial template as a hierarchical tree-structure. This structure corresponded to our initial research model’s structure as illustrated in figure 2. In this structure Outcome is expanded to show sub-codes for illustrative purposes. The research model that initially guided data collection thereby provided the initial constructs on characteristics of context possibly influencing on the enterprise modeling process, constructs on characteristics of the enterprise modeling process and the outcome of enterprise modeling.

The overall tree structure shown in figure 2 was kept during the coding process whereas sub-codes were altered and/or became part of the tree-structure as the analysis progressed. At the end, a final version of the template was defined, into which all transcripts and additional data had been coded. The final version served as the basis for our interpretation of the dataset and the writing-up of our findings.

Figure 2: The initial node tree structure

The material was re-read several times to examine that nothing essential had been missed in the reading process. Missed text sequences were attached to existing or new nodes. Thereafter followed a process where all material linked to each node was controlled, to make sure consistency between selected text and the node assigned. Thereafter, there was a process where material connected to a particular node was questioned to see if it should be broken into sub-nodes. If a sub-classification seemed appropriate, the change was made.

The coding process resulted in an array of different constructs representing findings on enterprise modeling practice.

To aid in the comparison of the eight combined process change and ICT-initiatives we used built-in query capabilities in the software application. To increase our understanding of the research material we supplemented Nvivo with the use of a spreadsheet program while looking for latent patterns in our material from an overall analysis perspective. The spreadsheet program helped us ensure that each relationship in our initial research model was examined and provided illustrative capabilities in accordance to our needs. See Appendix A for a list of matrices generated to search the material for latent patterns. In the Appendix most of the matrices have been transferred into Word to ensure readability on print.

As part of our overall analysis we also built a code-structure to keep track of explicit statements in our material of specific relationships between categories of enterprise modeling practice. The code-structure of explicit statements increased our ability to track interview statements supporting or challenging our latent analyses.

The single case study of the Home Builder, focusing on the recommendations and experiences on enterprise modeling as seen by the project manager, is presented in Karlsen and Opdahl (2012c). To analyze this material we again produced a node structure to keep track of the experiences of the respondent. Thereafter we linked the experiences and recommendations to four steps of modeling supported process change which emerged during the coding process.

3.6 The research process summarized

The research process can be visualized and summarized as shown in figure 3.

As indicated in this figure, the work on constructing an initial research model led to the first publication in the research project, Paper I, presented in Karlsen (2008). After having investigated the eight cases with the help of the developed research model, four additional papers were generated: Paper II presented in Karlsen and Opdahl (2012a), Paper III presented in Karlsen (2011), Paper IV in Karlsen and Opdahl (2012b) and Paper V in Karlsen and Opdahl (2012c).

Paper II identified five different modeling initiatives related to our cases and focused on the outcome of enterprise modeling. Paper III focused on the context for enterprise modeling and modeling practice and gave answers to which artifacts, guidelines and tools where used for enterprise modeling. In addition this publication presented three types of barriers to enterprise modeling. The paper also presented the finding that distribution of modeling maturity between project stakeholders affects how enterprise modeling activities are carried out. The fourth publication presented findings from the overall analysis of the eight cases, and presented the validated and elaborated Enterprise Modeling Practice model. The fifth publication presented findings on enterprise modeling use in a turn-around project. Each of the papers addresses aspects of enterprise modeling use. Together they paint a broad picture of the complexity associated with enterprise modeling use in real-life projects.

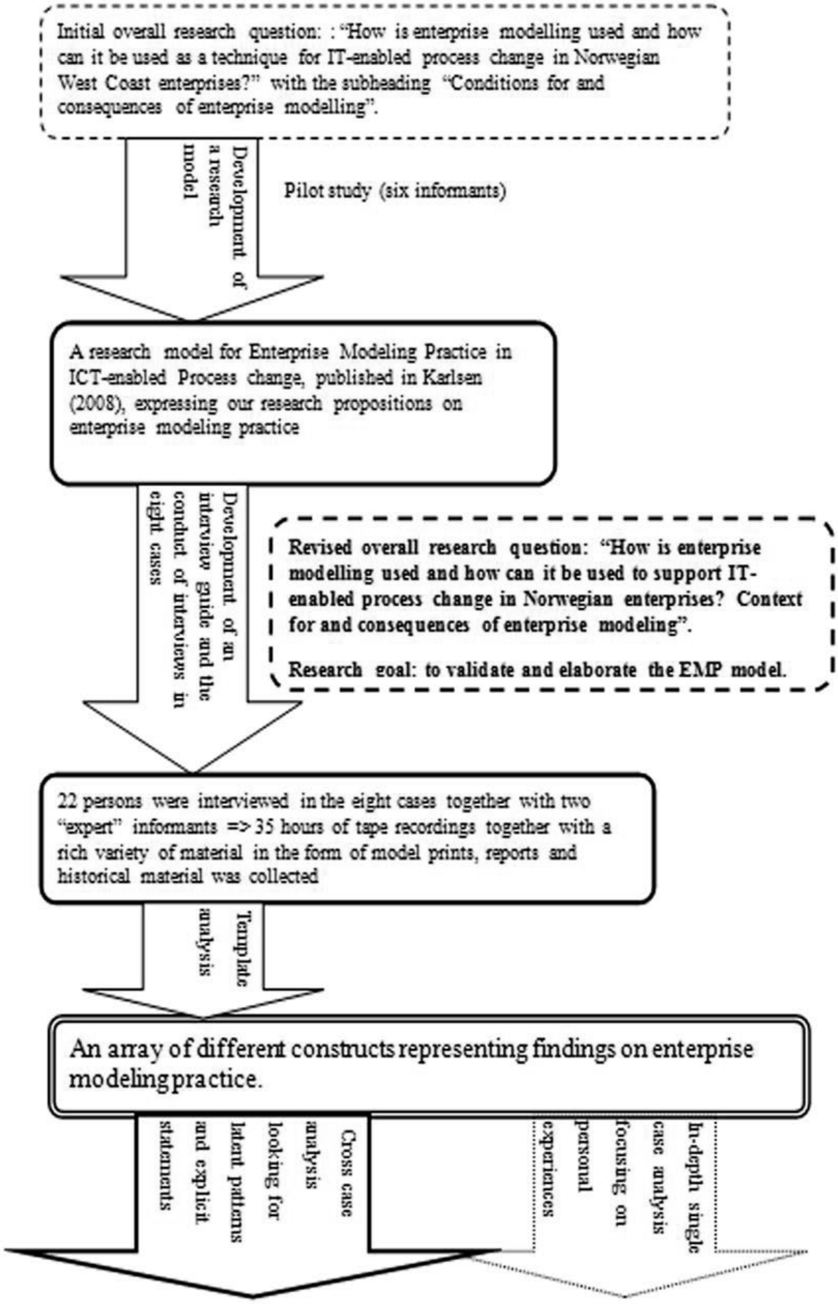

Figure 3: The research process

4. The research findings

In this section we summarize our findings by referencing the various papers written in relation to the research process, the overarching research question, the initial research propositions and the overall goal of the study.

4.1.1 Paper I

Title: A research Model for Enterprise Modeling in ICT-enabled Process change.

Purpose of the paper: This paper was written as a result of developing a research model to guide our investigation on the use of enterprise modeling in practice.

Background/Motivation for the paper: The motivation for developing the research model and write about it in a publication was based on a recognition that there were few empirical studies on enterprise modeling practice in general and few on enterprise modeling use in ICT-enabled process change in particular. To guide our empirical study we were in need of a model addressing the universe of discourse of our study. We concluded that besides being a research model made for our particular project, the Enterprise Modeling Practice research model should be interesting to others engaged in practical ICT-enabled process change by exhibiting key factors thought to influence and being influenced by the modeling process. The Enterprise Modeling Practice study was initiated to supplement the Process Modeling Practice study by Eikebrokk et al (2006) looking into model supported process change practice. Based on this, it seemed sensible to let the Enterprise modeling research model build extensively on the Process Modeling Practice model concerning categories, definitions and motivations, thereby making findings from the two studies comparable. At the same time there were fundamental differences concerning the model build-up and scope of modeling practice research between the Process Modeling Practice study and the Enterprise Modeling Practice study. Whereas the Process Modeling Practice study focused on process modeling in process change, paper I described a research model made for a study with a wider perspective or scope; looking into the making of enterprise models in conjunction with process change enabled by ICT. Due to this, the model incorporated elements associated with enterprise modeling and ICT development found in literature that has not been a matter of concern in the Process Modeling Practice study. In addition the model incorporated factors from a pilot study. The additional categories particularly related to project-specific characteristics, but other sub-categories were also found, and presented to the reader.

Findings presented in the paper: Building on categories and sub-categories from the field of process modeling, the model described in Paper I describes a variety of propositions concerning enterprise modeling practice, thereby evoking various directions for further study. The model expressed our research propositions on how various categories in enterprise modeling practice would interact in the cases under investigation, as described in section 3.2 of this thesis.

As examples of questions that can be drawn from the model we list the following examples:

- For what purposes are enterprise modeling used in ICT-enabled process change?
- How does the purpose of the enterprise modeling affect how the modeling process is carried out?
- How is the modeling process affected by the level of initial process-, and modeling maturity?
- Do more elaborate enterprise modeling processes tend to produce and use more complex model artifacts and vice versa?

In our own research effort we found this paper useful as a reference in other papers but also as a useful information source when working on the overall analysis of our material. Category-by-category and definition-by-definition we compared our findings with our initial assumptions. In this circumstance the paper was particularly useful as a tool when we had to lean backwards and ask ourselves: What are our findings? How do they differ from or verify our initial expectations? Through such a comparison process our validated and elaborated Enterprise Modeling Practice model could be presented in Paper IV.

4.1.2 Paper II

Title: Benefits of different types of enterprise modeling initiatives in ICT-enabled process change.

Purpose of the paper: The paper aimed at presenting the benefits of enterprise modeling revealed through our study. In addition the paper focused on presenting our identification of five different types of enterprise modeling initiatives found via our analysis of how each case combined the use of ICT, the main focus of process change and the objectives of modeling; a theme directly addressing our overall research question on how enterprise modeling is used.

Background/Motivation for the paper: The choice of dedicating a paper to the benefits of enterprise modeling was linked to our initial research objective to identify consequences of enterprise modeling in practice. In addition, Indulska et al. (2009) stated that little is known of actual benefits of process modeling in academia and practice. To our knowledge, not much is known on the benefits of enterprise modeling in ICT-enabled process change either. A possible contribution of our work was stated as avoidance of similar situations as described by Indulska et al (2009), where lack of insight makes modeling a time-consuming and costly exercise and makes it difficult to convince executive management of its benefits.

Findings presented in the paper: We started by showing that among our eight cases, seven cases focused on changing information flow as part of process improvement. Five cases focused on altering work practice. Of these, two cases focused on improving work practice by technology, whereas three cases altered work practice by physical intervention. Four cases had a double focus on altering both work practice and information flow. Next we presented our findings of four different types of ICT-initiatives associated with the cases under investigation: (1) Introduction of a quality system, (2) Introduction of a wearable voice-directed warehouse application system, (3) Development and introduction of an industry-specific ERP solution and (4) Introduction of a standardized ERP solution. Next, the readers were presented with our analysis on modeling objectives associated with the various change efforts, where the coding process led to the identification of six types of modeling objectives which we identified by quotes from the informants: (1) Modeling to reveal the AS-IS situation, (2) Modeling as input to a report, (3) Modeling to reveal the build-up of applications, (4) Modeling to fill a quality system with process descriptions based on a specific guideline, (5) Modeling to reveal differences between organization and system based on vendor supplied models and (6) Modeling to reach a strategy.

Having identified types of modeling objectives, types of ICT-initiatives and process change main focus, we then presented our findings indicating that these three project characteristics combined in particular ways in our selection of cases leading to the identification of five different types of modeling initiatives, termed Strategy, Industry, Dataflow, Work and Support.

After having presented the reader with the identification of the five different types of modeling initiatives, benefits associated with each type of modeling initiative were presented. In this circumstance we suggested that the focus area of the change initiative seems decisive for the enterprise modeling outcomes to be experienced and expected. To check this assumption we investigated the distribution of all cases within each type of modeling initiative with the overarching type of modeling benefits. This resulted in the finding that each type of modeling initiative produces the same constellation of overarching types of modeling benefits. We further on presented our findings indicating that strategy initiatives mainly focus on modeling to accomplish an overarching change strategy, whereas Industry, Dataflow and Work initiatives have stronger focuses on the technological part of ICT-enabled process change. Industry initiatives were subdivided into one part of the initiative focusing on the actual making of the industry-specific ERP solution and another part where the specific ERP solution is adopted in an organization. The benefit of enterprise modeling in the first part of the initiative was by our interviewees described as an aid in settling for an appropriate solution. The other benefits related to the second part and the making of models as input to a preliminary report. We found that Dataflow initiatives bear resemblance with the modeling effort associated with the second type Industry initiatives, but, where the Dataflow initiatives focus on specifying what requirements should be made concerning a future IT-solution, in the Industry initiatives the solutions are given leading to a focus on identifying necessary alignments between processes and the industry-specific solution. Further on we stated that Support initiatives are the only ones that focus on the creation of business support environments, with the benefits associated with modeling primarily linked to model sharing and availability. We found that these benefits can be seen as long term gains whereby the common model reservoir in the long run helps the organization making safer decisions etc. based on a common understanding of business processes. Comparing the Strategy to the Support initiatives, we saw some similarities between the two modeling initiatives if one eliminates the time factor associated with having to fill a business support system, e.g. a quality system, with models before one in the next step is able to reap the benefits of modeling. We concluded that the change focus associated with Strategy initiatives focuses on organizational change at large, involving both the redesign of work processes and improving the information base to support work accomplishments. In this sense this change initiative had a broader focus than the change initiative associated with Work, with its focus on the introduction of a new technological solution. In the Strategy initiative economical, organizational, project-related and technological benefits were identified and presented.

4.1.3 Paper III

Title: Enterprise Modeling Practice in ICT-enabled Process change.

Purpose of the paper: Where Paper II presented our finding of five different types of modeling initiatives associated with our cases, Paper III aimed at supplementing this finding on how enterprise modeling is used, by especially focusing on these sub-questions:

(1) How is the enterprise modeling process organized?

(2) How is participation and involvement in the enterprise modeling process?

(3) Which tools, languages and guidelines are used for enterprise modeling?

(4) Which artifacts are produced in each type of modeling initiative?

(5) What might influence the selected way of organizing the modeling process as for example workshops with oral participation or workshops with active participation?

(6) Are there any barriers to modeling to be identified?

Background/Motivation: Our research and publication was motivated by the fact that little is known on enterprise modeling in practice and our corresponding wish to publish our findings related to our overall research question on the actual use of enterprise modeling in real life enterprises.

Findings presented in the paper: Concerning the first question raised in the paper our analysis identified various ways to organize the modeling activities, as: (1) Workshop with oral participation, (2) Workshop with active participation, (3) User forum, (4) Supply your input, (5) Group-based model use and (6) Individual modeling. Comparing our cases further indicated that even though people are not directly involved in the actual drawing of the models, their involvement and participation were seen as satisfactory or very good in all cases. Coming to tools, languages and guidelines used for modeling, our study showed that in most cases simple modeling tools like Word and Excel were used. In the Banking case the quality system application itself was used for modeling. In addition we found a highly varied practice in the bank across departments and project participants. In the Industry case tool use differed among participants.

Concerning guideline use we concluded that our analysis showed that this varied along the time-axis of the project lifecycle and among project participants. In the Support initiative they had a common framework on how to build the quality system for modelers and facilitators. They also used external consultants in each business area to make sure that the modeling standard was followed. In three cases external consultants used a consultant variant modeling guideline in their work. In one case it was reported that before the consultant entered the company, no concrete guidelines were used. In another case, a process description from a similar enterprise was used as a template to set up a description of the company's own processes. But in general no specific modeling guidelines were used. Concerning modeling language we presented the finding that the majority of cases reported that no specific languages were used. In cases where modeling language were reported to be used, it turned out that they spoke about some sort of a "consultant variant".

Concerning which artifacts were produced in each type of modeling initiative, analysis showed that in all cases process descriptions were made as part of the process change process, except in the Work initiative, where models were used. We also found that technological models were developed in three cases: In one case Use Cases were developed, in another case database models were developed and in one case a system draft evolved in parallel with the development of the process descriptions. In one case we found that technological models of different solutions were used years ago, when developing the joint industry-specific solution. In another case we found that models from other sources, textbooks and downloaded documents from the Internet, were adapted to be used as part of the process change process to illustrate to employees in the main organization what was meant by a holistic enterprise understanding.

For the question “What might influence the selected way of organizing the modeling process as for example workshops with oral participation or workshops with active participation?” we compared the respondents’ answers on modeling maturity, the main organization’s and the externals’ modeling capability and experience of modeling (See Appendix A, table 14 for details). In this circumstance we concluded that in most cases the externals’ capability of modeling is seen and reported as high, or at least much higher than what is the case in the main organization.

By comparing the ways of organizing the modeling activities with modeling maturity of different project participants, we more specifically were able to conclude that: (1) In cases where the modeling maturity of the external representative is reported as high and the modeling maturity level of the main organization as low or medium to low, workshops with oral participation is used to organize the modeling efforts. This way of organizing the modeling activities is in some cases supplemented with individual modeling, whereby the external representative sits down and does modeling by himself based on interview inputs, (2) In the case where modeling maturity is reported as high both in the main organization and among the external participant, workshops with active participation is used, (3) In the case where the modeling maturity level is reported as low both in the main organization and among the external participant, group-based model use is applied. In this instance lack of knowledge on modeling does not stop the participants from finding vendor supplied models useful in the project (Karlsen, 2011).

In the initial research model ‘Resistance’ was one of the sub-categories of the enterprise modeling process. In the paper we concluded that there are in fact different types of barriers to modeling that hinder the actual use of modeling in ICT-enabled process change, for example low staffing levels, bad economy and lack of time.

In general when comparing our findings with the initial research model we concluded that an enriched picture of enterprise modeling practice was painted via our collected material.

4.1.4 Paper IV

Title: Enterprise modeling in initiatives that combine process change and information and communication technology.

Purpose of the paper: The paper addressed our research goal to validate and elaborate the Enterprise Modeling Practice research model. Implications of empirical findings from our case study subject to our initial research model were examined.

Background/Motivation for the paper: The paper was motivated by lack of empirical research into enterprise modeling practice, and correspondingly aimed at increasing knowledge by presenting our real-life projects findings associated with our overall analysis.

Findings presented in the paper: We went through the propositions and relationships stated by the a-priori model (Karlsen, 2008) and compared them to our empirical findings in a step-wise manner. The outcome was a revised enterprise modeling practice model, presented in Karlsen and Opdahl (2012b).

We concluded that Individual modeling or workshop should be renamed Modeling organization to show that modeling can be organized in more nuanced way than initially expected.

We found support for the initial expectancy that Individual modeling or workshop affects Eventual process maturity.

We found that Participation and involvement in Enterprise modeling relate to Outcome

We redefined Participation and involvement as: "t*he importance of stakeholder involvement and participation in the modeling process, for the design, approval, and/or use of enterprise models"*

We made Project management and systems development a combined category, possibly dictating how to model objects and processes.

We found that Management support influences Outcome. We concluded that modeling Outcome can increase Management support during the project, thereby giving rise to seeing the two factors as interrelated and enforcing in both directions.

We initially expected Resistance to be related to Model artifact. Investigating our material did not reveal such a relationship. Instead we found that resistance was a barrier which often diminished as part of the modeling process. We concluded that modeling can reduce Resistance thereby leading to the inclusion of a relationship between Outcome and this type of barrier in the revised model. In addition we identified Moderators as barriers to modeling, reducing the likelihood of modeling.

In the a-priori model it was expected that Modeling Tool influences Outcome. We identified such a relationship. Further on we found that Outcome of modeling depends on Model artifacts produced or used.

Modeling objective as category was not part of our initial model. However we found it operating in a constellation with Process change main focus and type of ICT-initiative to define Type of Modeling initiative. Based on this we introduced it as a new category in the revised model. In addition we found that Modeling objective influences Outcome, being part of a specific type of modeling initiative shown to produce a specific set of modeling benefits.

A comparison of organizational Modeling maturity to the organization of the modeling activities, e.g. Modeling organization, indicated a relationship between these categories.

We emphasized that analysis of the latent pattern combined with explicit statements indicate that level of Process maturity is decisive for Modeling organization. Due to this Process maturity was kept in the revised model. We also found that Process maturity influences Modeling organization.

Concerning Technological maturity we concluded that this category should be kept in our revised model influencing Model artifact. We found that Modeling expertise influences Enterprise modeling. With reference to the analysis of Modeling maturity as a sub-category of Organizational characteristics we concluded that Modeling expertise influences Modeling organization.

Process expertise of Project participants became a category of the revised model. This new category was defined as "*an individual's capability for process management and operation, including available competence and current practice*".

We renamed Purpose to Process change main focus in accordance with our findings described in Karlsen and Opdahl (2012a). There it was shown that types of modeling objectives, types of ICT-initiatives and process change main focus combine in particular ways in our selection of cases. This led to the identification of five different types of modeling initiatives termed Strategy, Industry, Dataflow, Work and Support.

Process change main focus was found to influence Artifacts produced, by dictating which artifacts were in demand. We concluded that Process change main focus deserve its place as an influencing factor on Enterprise modeling in our revised model.

ICT-based future solution was kept, with the alternative term ICT-initiative, as a category influencing Modeling Tools based on our findings. In one of our cases we found that it was actually the processes that dictated the ICT-solution. The relationship between ICT-solution and business process in the form of Modeling artifact was found to be bidirectional.

Project management and Systems development was made into a combined category in our revised model dictating how to model objects and processes.

We concluded that various types of modeling initiatives produce different constellations of types of modeling Benefits (Karlsen and Opdahl, 2012a). The model had to be adjusted in accordance to these findings.

The comparison process led to a broadly validated and elaborated model of enterprise modeling practice.

While our findings showed that most of our initial expectations from the field of process modeling were relevant for enterprise modeling practice also, we also made findings that elaborated the initial picture. Please refer to Karlsen and Opdahl (2012b) for further details on this subject.

4.1.5 Paper V

Title: Enterprise modeling practice in a turn-around project

Purpose of the paper: The paper described enterprise modeling practice in a small Norwegian home builder company. The purpose of the paper was to give insight into modeling use by reporting modeling experiences and recommendations. Change was identified and presented as a three stage process: (1) Change maturation, (2) Change decision and (3) Process change, where the last stage constituted four steps of modeling supported process change: (1) Increased business understanding by providing a generic model, (2) Identification of TO-BE by process modeling, (3) Process categorization by sorting models into risk zones and (4) Implementation of prioritized change consistent with model artifacts. Readiness was identified as a precondition both for change and for doing modeling at all. The paper also investigated the importance of employee involvement and anchoring in senior management.

Background/Motivation for the paper: The paper directly addressed our research question on how enterprise modeling can be used. So far our research had aimed at comparing and finding commonalities across various cases. In this paper we instead used our data to investigate a single case in particular. An inspiration was Indulska et al's (2009) call for exploration and publication of success studies and King (2004) warning that individual participant's voices are in danger of being lost when comparing cases. In addition we saw the possibility of improving our study by adding longitudinal elements to our portfolio of findings, inspired by Eisenhardt and Graebner (2007).

Findings presented in the paper:

Based on the history of what happened, we summarized the change process as three main stages: (1) Change maturation, (2) Change decision and (3) Process change. The change maturation stage lasted for several years and led to a moment in time where the risk of bankruptcy was evident. The change decision was made by the board. They had a meeting with all employees, asking what they as a company was good at and what they were poor at. Thereafter the company went into a year-long period of process change where profit increased.

We presented two figures of Profit margin and Return on Equity, and concluded that while competitors kept struggling, the Homebuilder improved profit in the period of process change.

By combining various sources of evidence, we described the Process change stage in terms of four modeling supported steps: (1) Increased business understanding by providing a generic model, (2) Identification of TO-BE by process modeling, (3) Process categorization by sorting models into risk zones, (4) Implementation of prioritized changes consistent with model artifacts, where steps (2), (3) and (4) were iterated.

For each modeling supported step, we then presented the facilitator's experiences and recommendations.

We found that in the Home Builder case, enterprise modeling was used as a tool to increase the ability to make good decisions, in the short run used in workshops and discussions, in the long run as artifacts hung on the wall and as implementations into well-functioning processes. The focus had been on interaction and process improvements, combined with the introduction of new procedures and an ERP-system. The focuses led together to improved control, overview and flow. It was acknowledged that how the employees and the executive management behaved on a daily basis influenced the result. The role of strategic management was also regarded as important. From various statements it was evident that the facilitator had put a major effort into selling the idea of mapping the business processes to be able to understand what to do and what to change. The use of a generic, high level enterprise model had helped people understand how things flowed in the form of goods from the suppliers and on to the construction site etc. The use of a generic model also increased readiness further, by improving the ability to understand why things had to be done and what had to be done.

We compared the approach followed in the Home Builder case with what Davenport and Short (1990) observed as typical steps in successful process redesign. The conclusion was that there was a rather good match between the two. In line with Davenport and Short (1990), we for example noticed that the facilitator used time on developing shared vision and process objectives by educating various employees on the need for process interaction and orchestration. We also found a good match with the stages in the reengineering archetype presented by Kettinger et al. (1997).

Due to the similarities between actions performed in the Home Builder case and the steps envisaged by Davenport and Short (1990) and Kettinger et al. (1997), we concluded that the combination of steps taken and enterprise modeling use explained project success.

5. Discussion

The following discussion addresses the main areas of the project: Section 5.1 addresses the overall research question "*How is enterprise modeling used and how can it be used to support ICT-enabled process change in Norwegian companies? Context for and consequences of enterprise modeling"* together with a discussion on the validation and elaboration of the Enterprise Modeling Practice model. The discussion on these themes is focusing on our findings presented in the various papers produced as part of our research process. Section 5.2 looks into methodological issues.

5.1 The overall research question and goal

5.1.1 The use of enterprise modeling

At the onset of our research project we knew little of what to find on how enterprise modeling is used in ICT-enabled process change due to little previous research on this topic. Researchers' statements that enterprise modeling was especially useful at the requirements stage of systems development made us think that we would especially find enterprise modeling used in such circumstances. Our first meeting with our expert informants changed that view. It became evident that enterprise modeling has a role to play in various circumstances in a change process.

In Person and Stirna (2001) it is shown that enterprise modeling can be used for two main types of objectives: (1) developing the business, e.g. developing business vision, strategies, redesigning the way the business operates, developing the support information systems, or (2) ensuring the quality of the business, e.g. sharing the knowledge about the business, its vision, the way it operates, or ensuring the acceptance of business decisions through committing the stakeholders to the decisions made.

By comparing our cases we found that each was linked to one of five different types of enterprise modeling initiatives associated with ICT-enabled process change. These were termed *Strategy*, *Industry*, *Dataflow*, *Work* and *Support*. Comparing the different enterprise modeling initiatives to this classification of Person and Stirna (2001) led to the conclusion that in general one can relate *Strategy*, *Industry, Dataflow* and *Work* to the first type of main objective, whereas *Support* can be linked to the second main objective.

We identified the five modeling initiatives by investigating how the cases clustered together and shared a commonality concerning type of ICT initiative, Project change main focus and Modeling objectives (Karlsen and Opdahl, 2012a). Per se each of these identified initiatives demonstrates enterprise modeling use, and thereby can trigger ideas on how enterprise modeling can be used in other change processes. We found that three of the cases clustered together in what we termed the *Strategy* initiative where enterprise modeling is used to reach a change strategy in a long term business change initiative with a mixed focus on improving work practice via physical intervention and improving information flows via ICT. Two cases clustered together in the *Dataflow* initiative where enterprise modeling is used to reveal AS-IS as input to a requirements specification in a change effort to improve information flows. One case corresponded to what we termed the *Work* initiative. Here vendor supplied models are utilized to unveil differences between a wearable voice-directed warehouse application system and the organization in a change effort to improving work practice by technology. In one case modeling was used to fill a quality system with process descriptions based on a specific guideline, focusing on developing a business support environment where it was expected that in the long-run shared common models of work practice would improve business. This initiative was termed *Support*. In one case we found that modeling was used to uncover the build-up of market leaders' IT solutions to develop a joint industry-specific IT solution. In addition modeling was done to make input to a preliminary report to communicate the necessary alignment between this joint solution and specific actor needs. The initiative was termed *Industry* to emphasize enterprise modeling use in conjunction with the development of an industry specific solution, and also to distinguish its focus from the other initiatives.

The identification of the five modeling initiatives does not present the complete picture on how enterprise modeling is used. It merely describes how enterprise modeling is used in course of a change process; linked to the mission or objective of modeling in an initiative that combines process change and ICT. Enterprise modeling practice is also about the making or use of concrete artifacts, the use of specific tools, languages and guidelines and the organization of the modeling activities.

Focusing on these aspects showed that simple tools and little use of guidelines and languages were the standard and not the exception. See Karlsen (2011) for details. We were not particularly surprised by this finding. Previous research associated with the sub-field of process modeling point in the same direction. In addition, from my own teaching at Aalesund University College I have seen many students struggle with model making, both the use of simple tools and the ability to abstract thinking. I also remember that in my own early school-days modeling and other "soft issues" was not number one on the reading and practice list to become a computer engineer. I therefore had a vague initial feeling that modeling would not necessarily turn out to be *high level* in the enterprises under study.

Concerning the artifacts produced, our study showed that among our cases both process descriptions, meta-models, organizational charts and technological models were made as part of the change processes. In all cases process descriptions were made, except in one case where vendor supplied models were used. Meta models were produced in the *Support* initiative, whereas technological models were found in the *Dataflow* initiatives, in one of the cases of the *Strategy* type of initiative and in the *Industry* initiative. In one case typified as a *Strategy* initiative, adapted models from text books and other sources were also made as part of the change process.

The finding of various process descriptions fits well with Davies et al's (2006) finding of flowcharting and business process documentation as high ranked purposes of conceptual modeling. That the research project focused at process change can also explain the central role of process descriptions in the projects under study.

In our initial research model we operated with the category Individual modeling or workshop. Initially it seemed plausible that modeling sessions either are organized as a workshop or done on an individual basis in accordance to Process Modeling Practice model described by Eikebrokk et al (2006). Looking into our cases the picture became more detailed. In fact we found that in the *Strategy*, *Dataflow* and in the *Industry* initiative, modeling activities were organized as workshops with oral participation. E.g. modeling was written down by an external consultant, whereas participants of the main organization provided oral inputs to the modeling process. This was not the case concerning the *Work* or *Support* initiative. In the *Support* initiative workshops were used with active participation in the modeling activity. Here employees did concrete mapping of business processes. In addition the quality system initiative was supplemented with the possibility for all employees in the bank to provide inputs to model layouts via a digital mailbox-system named *Supply your input*. The bank also organized a specific user forum where modelers from each business area were represented. The user forum made decisions on whether specific process change suggestions collected via the *Supply your input* should be universally applied in the banks' preferred process portfolio. If so, the corresponding process model in the quality system was changed. Group based modeling was used in the *Work* initiative, where a group of representatives from the main organization and external representatives compared vendor supplied models with what was going on in the warehouse building. Differences were subject to debate and led to necessary tweaks between system and process layouts. A specific aspect associated with our cases was that external consultants and IT-vendors were part of the business relationship with the main organization. We termed them externals and checked the relationships between the ways of organizing the modeling activities related to the modeling maturity of different project participants. Based on this analysis, we in Karlsen (2011) proposed that what might influence the chosen way of organizing the modeling activities seems to be linked to the distribution of modeling maturity of project stakeholders. E.g. whether one chooses to do the modeling activities by oneself of chooses to commission an external consultant, and whether one chooses to involve the project participants actively in the modeling process depends on having or lacking modeling competence. In addition we found that people can contribute to the modeling process also by supplying suggestions on improvements without actually being the person putting the thoughts down on paper. Possibly one characteristic shared by the various cases was that efforts seemed to be put into the various projects to ensure cooperation and involvement of various employees to make the process change processes successful.

5.1.2 The context of enterprise modeling

In general we found that modeling practice depends on both organizational, project-participant and project-specific characteristics where some factors actually may hinder the use of modeling in the first place. We found for example that project participant characteristic, project specific issues, IT-system issues, information issues and resource specific issues hinder the actual use of enterprise modeling in ICT-enabled process change. For a full list of barriers identified, see Karlsen (2011).

A surprising finding was that resistance was reduced during the process in three of the cases. It was reported that resistance was changed when they experienced the system in practice and when they started seeing the real point of modeling. One of the interviewees stated that "*If you can tie modeling up against initial resistance, modeling actually helps because we can more easily see what the problems are*" (2. Interview, C3, reported in Karlsen (2011)).

The *Support* initiative was the only instance where conceptual problems related to understanding graphical images was reported. One explanation can be that this is the only type of modeling initiative where models are made by some individuals and then subjected to understanding by others at another place and time. Here the understanding must be linked to the notation used, whereas in the other modeling efforts the understanding of the model is closely interlinked to the project participant's direct communication on the meaning of the models developed.

In general our study demonstrated that most of our initial expectancies on relevant contextual categories from the field of process modeling are relevant also within enterprise modeling as can be seen from figure 4.

5.1.3 The outcomes of modeling

Table 5 provides a summary of benefits associated with the various types of modeling initiatives. For a more detailed presentation, please refer to Karlsen and Opdahl (2012a).

SUPPORT	STRATEGY
A common basis for discussion	A common picture of the business
A holistic view of the enterprise	A communication tool
A strategic tool	A modified atmosphere/Culture change
A tool for managing IT-entries	A more positive attitude towards modeling
Actual process change	Actual process change
An awareness-raising process	An awareness-raising process in itself
Common picture of the business	Change in modeling competence
Common understanding of business processes	Change in operating focus
Improved decision making	Changed mindset
Improved process efficiency	Employee training
Improved service quality	Improved working environment
Increased ability to act	Increased ability to act
Increased ability to process thinking	Increased ability to process thinking
Increased availability	Increased control into corporate finances
Making documentation simpler	Increased earning power
Making the intangible tangible	Increased efficiency in the interaction
More positive modeling attitude	Input to the systems-related
On a personal level	Insight into status quo; challenges etc.
Reorganization	Market confidence
Safer decisions	On a personal level
Simplified employee training	Optimism and motivation
Simplified mobility of employees	Reduced change resistance
Simplified working /Uniform work methods	Reorganization and overview of who and what
INDUSTRY	DATAFLOW

A compressed image of areas the IT-solution must meet	A compressed image of areas the IT-solution must meet
A thinking tool	Actual process change
An appropriate solution	An appropriate solution
Being prepared to meet with the supplier	Further involvement in the organization
Disclosure of existing procedures	Increased ability to act
Adjustments between processes and system	Input to the requirements specification
Input to preliminary report	Input to the systems-related
Insight into corporate challenges etc.	On a personal level
Potential input to quality system	Potential input to a quality system
Understanding of systems requirements	Qualified choice of IT-provider
WORK	
Actual process change	
Reorganization of the business plant	
An awareness-raising process in itself	
A common picture of the business	
Systems-related input/Appropriate solution	
Disclosure of necessary processes and system tweaks	

Table 5: Benefits of different types of modeling initiatives

Investigating the organizational benefits identified, we concluded that enterprise modeling can be used as a tool or technique to increase the efficiency in the interaction between various project participants. In addition enterprise modeling can be used as a tool to change operating focus. From an environmental perspective, enterprise modeling can be used as a tool or technique to modify the atmosphere in the organization, reduce resistance and produce optimism and motivation. From a managerial perspective enterprise modeling can be used as a tool or technique for employee training. Concerning project-related aspects, enterprise modeling is described as an awareness-raising process in itself. Enterprise modeling in this circumstance can be used as a tool or technique to shape a common understanding of the business, functioning as a communication tool leading to increased understanding and reasoning which influence project participants' mindset, increase process thinking and leads to further involvement in the organization. For short we concluded that enterprise modeling can be used as a tool or technique to increase the ability to make good decisions. From a technological viewpoint, enterprise modeling can be used as a tool or technique to produce an image of important areas the IT-system must meet.

Comparing our findings with Indulska et al. (2009), our study confirms several of the benefits ranked highly by practitioners and vendors. Process improvement and understanding are among the benefits reported in their study. But some benefits ranked highly by academics, such as model-driven process execution, process simulation and process verification do not appear in our study at all. A possible explanation is that in our study the participants report on what they perceive as advantages of specific acts of enterprise modeling, whereas the participants in the Indulska et al. (2009) study seem to report on what they personally see as possible use or usability of modeling also.

Most interesting in our analysis on the outcomes of enterprise modeling is possibly our finding that benefits of modeling relate to type of modeling initiative in question, and therefore, in order to be able to give a qualified answer to executive management on the potential benefits of an enterprise modeling initiative, it is beneficial to identify type of modeling initiative in question. See Karlsen and Opdahl (2012a) for further details on this subject.

5.1.4 Modeling practice in the Home Builder case

The single case study of the Home Builder provided an extra dimension to our work by letting the voice of the project manager be heard. The lack of personal voices is a drawback with comparative case studies according to King (2004). In addition it provided an extra dimension in the sense of providing additional longitudinal elements to our portfolio of findings, as mentioned in Eisenhardt and Graebner (2007).

Due to our interview with the project manager we could make the following list of concrete advices on modeling use, thereby letting the voice of the project manager being heard:

1. Start by making the employees understand how various enterprise views are inter-linked and how the business processes can be described by introducing the concepts of information flow, work flow and the flow of goods. Visualization of the enterprise through a generic, high level model help people understand how things flow in the form of goods from the suppliers and on to the construction site etc. Use of the general model also helps creating readiness, by enabling the employees to understand why things have to be done and what has to be done.

2. Have workshops focusing on TO-BE since it is not particularly useful to discuss how things are done in a situation where things are done in so many and different ways. Ask: How is it best to do it? In this project LEAN was used as a strategic navigation aid for change. Concerning the question of using a specific notation for modeling, it is recommended that one uses both. At the early stage of the process it is easier to start by writing a few bullet points on the board to create an understanding of the flow, later on BPMN, as an example, is seen advantageous in terms of visualization capabilities.

3. Categorize process risks. The risks of processes differ, and if you map all processes and describe them in the highest detail, people get totally lost. People need to obtain an understanding and knowledge of how to handle those processes which are so crucial to business that if not properly executed, it will lead to a particularly bad outcome.

4. Make model artifacts available. The motive is to ensure that procedures are followed both now and in the future by presenting the artifacts where they are available and seen on a daily basis. In this matter remember that the models themselves do not guarantee things are conducted as decided, one also needs someone taking charge.

In addition to these recommendations and advices we were able to describe change to happen in three stages: (1) Change maturation, (2) Change decision and (3) Process change, where Process change constituted four steps of modeling supported process change: (1) Increased business understanding by providing a generic model, (2) Identification of TO-BE by process modeling, (3) Process categorization by sorting models into risk zones and (4) Implementation of prioritized change consistent with model artifacts (Karlsen and Opdahl, 2012c)

From various statements it was evident that the facilitator had put a major effort into selling the idea of mapping the business processes to make the project participants able to understand what to do and what to change. By showing the employees a generic, high level enterprise model, people where able to understand how things flowed in the form of goods from the suppliers and on to the construction site etc. The use of a generic model also helped increase readiness for change by improving the ability to understand why things had to be done and what had to be done. The actions performed fitted well with Armenakis et al (1993) recommending readiness creation through arguing and discussing.

Having increased business understanding by providing a generic model, the three iterative stages of identifying TO-BE, process categorization and implementation of prioritized changes were entered.

Davenport and Short (1990) saw two major approaches to identify and prioritize which processes are to be redesigned: (1) the exhaustive approach and (2) the high-impact approach. Comparing these approaches to what was done in the Home Builder case we find that the high-impact approach had been followed. This choice can be understood by the challenges the company was facing, where they had to act as quickly as possible by focusing on the aspects considered most grave.

The change of processes was followed up by making model artifacts available in the lunch room. In this circumstance, the facilitator experienced that model provision was not enough. In fact, the company manager had to take an active role in ensuring that things where performed as planned for. This was in line with Markus and Benjamin

(1997) who recommended that at least two team members should be designated as change agents.

Comparing the process change sub-steps in this case with the steps observed by Davenport and Short (1990) in successful process redesign, we conclude that there is a rather good match between the two. There is also a good match with the stages in the reengineering archetype presented by Kettinger et al. (1997). Due to the similarities between actions performed in the Home Builder and the steps envisaged by Davenport and Short (1990) and Kettinger et al. (1997), we conclude that steps taken in this project explain project success together with enterprise modeling used to support the change process.

5.1.5 Validation and elaboration of the Enterprise Modeling Practice research model

The Enterprise Modeling Practice research model was presented in Karlsen (2008). Via our research project we validated and elaborated this model, a process which resulted in the revised Enterprise Modeling Practice model, figure 4, presented in Karlsen and Opdahl (2012b)

To validate the initial research model we started by summarizing our initial expectations on enterprise modeling as mentioned earlier.

During the research process we did several findings detailing the initial picture. An example is the initial category Individual modeling or workshop, where both Workshop with oral participation, Workshop with active participation, User forum, Supply your input, Group based model use and Individual modeling were identified as ways to organize modeling activities in the projects under study.

We also found new categories as <u>Moderators</u> and <u>Modeling objectives</u> in addition to an array of various benefits of modeling related to type of <u>Modeling initiative</u> in question.

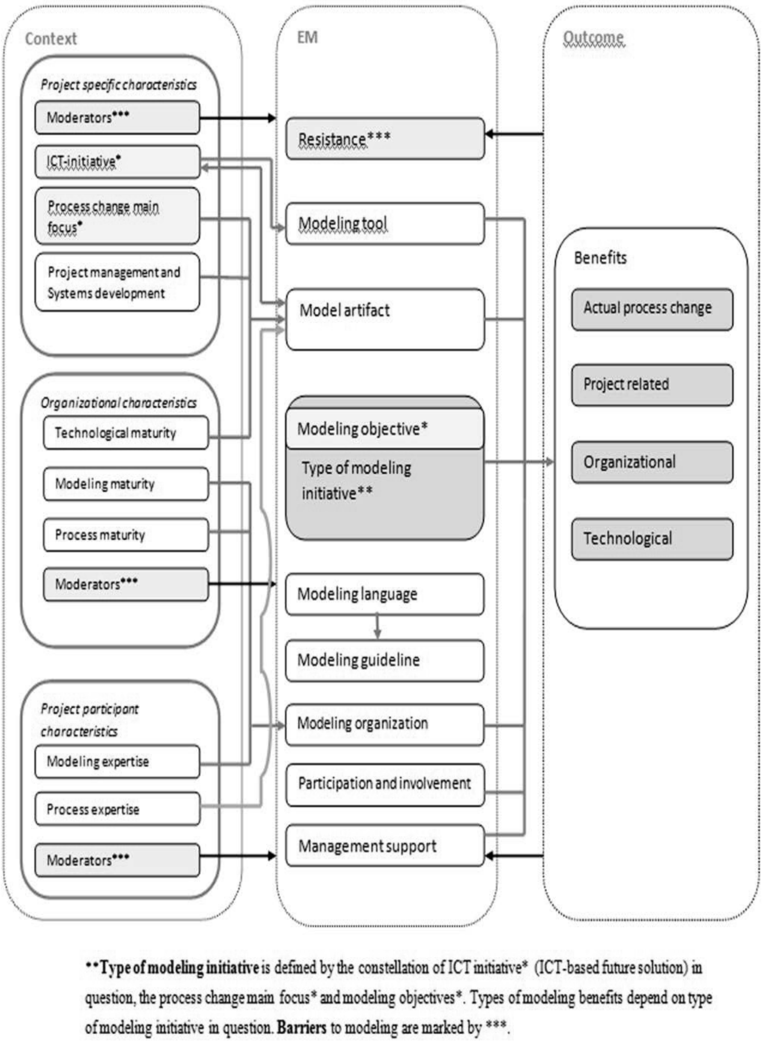

Figure 4: The Revised EMP model, Karlsen and Opdahl (2012b)

In general, our analysis showed that the combination of ICT-initiative, Process change main focus and Modeling objectives influences modeling Outcome. It also showed that Type of modeling initiative, Modeling organization, Participation and Involvement, Management Support, Model artifact, Resistance and Modeling maturity are important categories for understanding enterprise modeling. In fact, most of our initial expectations proved their relevance also within enterprise modeling.

This finding should be interesting both for researchers that so far have focused their research effort towards process modeling, and researchers that have focused on enterprise modeling in practice, since it indicates a close relationship between the two research focuses.

5.2 Methodological issues

Multiple cases stand on their own as analytical units serving as replications, extensions and contrasts to emerging theory (Yin, 1994; Eisenhardt and Graebner, 2007). Case studies emphasize the rich, real-world context in which phenomena occur as opposed to laboratory experiments isolating the phenomena from their context (Eisenhardt and Graebner, 2007). This is strong arguments for performing case studies when aiming at investigate enterprise modeling in practice.

Yin (2009) warns that a case study investigator might fail to develop a sufficiently operational set of measures and might use subjective judgments to collect data. To avoid these pitfalls, we took precautions throughout our research to ensure validity and reliability. As previously mentioned we started by developing the Enterprise Modeling Practice research model as an instrument to focus data collection as suggested by Miles and Huberman (1994). The research model constituted the theoretical propositions of our study and set the grounds for the development of our interview guide, which subsequently helped us keep focus in the interviews.

Initially we wanted to focus on the furniture, maritime and marine sector. After a process of searching for a relevant case within the furniture industry, we learned that an actor had a project in progress that could be highly relevant. Following this up lead to the realization that not all companies have the necessary time or willingness to participate in a research project, and that it was far too optimistic to decide on three distinct sectors in advance. In parallel with this incident, the search for other relevant cases took place. Soon we came in contact with a company that was more than willing to engage in the study, both by functioning as a door-opener to possible relevant cases and possibly by sharing their experiences as an IT-company. Their eagerness to help was possibly linked to the fact that the two managers of the company turned out to be old school acquaintances. After having paid them a first visit, and having received tips on a concrete possible follow-up, the telephone was used to get in contact with a relevant case within the maritime sector. In this matter the company was willing to have an initial meeting to discuss the possibility.

During the process of investigation, a wish grew to find a case with a more total systems approach to enterprise modeling than in the cases we had seen so far. We therefore searched the internet and found a company that develops and delivers a business support application based on the Zachman framework (Zachman, 1996). Contact with the company was useful. They directed us to a project they were involved in with one of the largest banks in Norway. They helped us get in contact with the project leader, and we visited the bank's main office outside the west coast region. The visit was surrounded by security, but resulted in five interviews with various persons at the bank accompanied by an interview with a representative from the IT-vendor. The material seemed so interesting for our investigation that we redefined our overall research question to not solely focus on companies at the west-coast of Norway.

Our experience in the search for cases led to the decision that a criteria for being included in the study should be that the organizations should be "available and willing", in the sense of being available and willing to provide in-depth insight into enterprise modeling practice through interviews and supplemental information. The second selection criterion was that the respondents defined the projects as ICT-enabled process change.

To supplement the interview process we collected relevant documents, because multiple sources of material increases construct validity (Yin 2009). To analyze the material we also relied on theoretical propositions, which Yin (2009) describes as the most preferred strategy for data analysis in case study research. We did this by letting the initial categories of our research model constitute the initial constructs in Nvivo. To further increase validity, we searched the material for latent patterns (see Appendix A for details on the matrices produced in this circumstance) and explicit statements.

The objective associated with reliability is to be sure that, if another researcher follows the same procedures as described by an earlier researcher and conducts the same case study again, the latter researcher should arrive at the same findings and conclusions (Yin, 2009). To allow for other researchers to repeat our case studies we made the a-priori research model available in Karlsen (2008). In addition both case information and the interview guide were made available in Karlsen and Opdahl (2012a). Nvivo was used to help us keep track of all collected case material, functioning as a case study database in accordance with recommendations by Yin (2009). By using this application we could run many queries and make many checks on our material that would have been impossible or at least very difficult without the embedded software facilities. Supplementing Nvivo with facilities offered in Excel we also secured increased control over our material.

We chose to use template analysis after having read King (2004) discussing and arguing on the benefits of using this specific analysis approach. King (2004) posts that a preference for template analysis instead of grounded theory may be based on one's philosophical position. Where the users of grounded theory have claimed that they are uncovering the "real" beliefs, attitudes and values of the participants in their research, researchers taking a contextual constructivist stance being skeptical of the existence of real internal states to be discovered through empirical research, may feel template analysis more conducive to their position. Template analysis is quite similar to Interpretative Phenomenological Analysis (IPA) in terms of development of conceptual themes and their clustering into broader groupings and the eventual identification across cases of master themes with their subsidiary constituent themes. The main difference between the approaches is linked to the use of a-priori codes and depth of individual case analysis before integration. Whereas IPA does not operate with a-priori codes, that is done within template analysis and when IPA tends to analyze individual cases in greater depth before attempting any integration of a full set of cases, that is not a precondition in template analysis (King, 2004). A fundamental tension in template analysis and in most qualitative research is between the need to be open to the data and the demand to impose shape and structure on the analytical process. Too much openness and the product can become chaotic and incoherent whereas too much structure can leave the researcher with all the drawbacks of quantitative research but none of the advantages. In this circumstance King (2004) veers toward an over-structured rather than an under-structured approach, because in his experience newcomers more often suffer from too much openness than too little. To comply with this we have tried to focus on structure and order when analyzing our research material. In addition to building a template for the EMP model, we built a supplemental template keeping track of concrete statements underpinning or challenging latent patterns identified via the analysis process.

King (2004) states that one of the most difficult decisions when constructing an analytical template is where to end the process of development since it is possible to continue modifying and refining definitions of codes almost ad infinitum.

Our study was conducted within constraints of time and money, implying the necessity to end the search for an ideal template after having read through the case material four or five times as part of the initial coding process. In this process we made sure that we had coded all relevant material and in addition challenged each sequence of text to see whether a further divide should be made. During this process sub-codes evolved which further broadened the picture of enterprise modeling practice. A good example is found in the coding process of Modeling organization, where we identified different ways of organizing modeling activities as: (1) Workshop with oral participation, (2) Workshop with active participation, (3) User forum, (4) Supply your inputs, (5) Group-based model use and (6) Individual modeling (Karlsen, 2011) after coding and comparing our material across all cases.

We have explicitly mentioned the work by Miles and Huberman (1994) in conjunction with the coding of our material. Miles and Huberman (1994) see social phenomena as existing not only in the mind but also in the objective world and that some lawful and reasonable stable relationships are to be found among them. They explain:

"*The lawfulness comes from the regularities and the sequences that link together phenomena. From these patterns we can derive constructs that underlie individual and social life. The fact that most of those constructs are invisible to the human eye does not make them invalid. After all, we all are surrounded by lawful physical mechanisms of which we're, at most, remotely aware*" (Miles and Huberman, 1994, pp. 4)

Whilst this quote might be seen highly philosophical, we emphasize it to demonstrate thoughts that have influenced our thinking. Huberman and Miles (1994) emphasize that the researcher's values are not minor and that the simplicity of qualitative data masks a good deal of complexity requiring much care and self-awareness on the part of the researcher. Besides Huberman and Miles (1994) and King (2004), Yin (2009) and Eisenhardt and Graebner (2007) influenced our choices and research approach followed.

On interpretation of data, Miles and Huberman (1994, pp.9) say:

"..what we consider as descriptive first-order "fact" rapidly ramifies out into the interpretations and explanations that people being studied have…, and into the

researcher's second-order conception of "what's going on" – the interpretations of the interpretations".

We have tried to address the danger of misinterpretation by explicitly quoting statements by various project participants, and comparing these statements to matrices produced to search for patterns across cases. Matrices have been included in the text to allow the reader to make judgments on conclusions drawn.

Our precautions on methodological issues do not eliminate a major limitation of any case study, namely the reduced ability to make broad generalizations. This is an obvious limitation of any study that aims to present a wide understanding of enterprise modeling by investigating modeling practice in-depth and within its real-life context in a limited number of cases. Our study therefore needs to be followed by additional research efforts as described in the Conclusion and Further Work section.

6. Conclusion and Further Work

The background for our choice of especially focusing on model development was the realization that very little research has been done on enterprise modeling in practice, and that an important contribution therefore could be to pave the way for further research within this area. The project was also initiated by a wish to have the conceptualizations of the Process Modeling Practice model (Eikebrokk et al, 2006) examined in a wider enterprise modeling setting.

Through the multiple case study we identified five different types of modeling initiatives by analyzing how each case combined use of information technology, process change main focus and the main objectives of modeling (Karlsen and Opdahl, 2012a). We also identified a broad variety of enterprise modeling benefits (Karlsen and Opdahl, 2012a) together with various barriers to modeling. We found a potential relationship between modeling practice and outcomes of modeling; e.g. that benefits of enterprise modeling depend on the type of modeling initiative in question (Karlsen and Opdahl, 2012a). This finding led to the conclusion that it is important to identify process change main focus, type of ICT-initiative and modeling objectives to be able to determine the type of modeling initiative before trying to give a qualified answer to executive management on the benefits of enterprise modeling in a specific context. In this circumstance one special finding should be mentioned: perceived benefits of modeling can change over time, calling for the necessity of some patience before expecting the true power of enterprise modeling in ICT-enabled process change. We also did findings indicating that the distribution of modeling maturity between project stakeholders affects how the modeling activities are carried out (Karlsen, 2011).

Finally, our multiple case study led to a broadly validated and elaborated Enterprise Modeling Practice model (Karlsen, 2008; Karlsen and Opdahl, 2012b).

Comparing our findings with the initial research model we conclude that the study has broadened the initial picture, for example on which outcomes to expect of enterprise modeling in initiatives that combine process change and information technology. Our study has additionally shown that categories from the sub-field of process modeling practice are relevant in the wider setting of enterprise modeling also.

Due to the limited number of cases under investigation our study must of course be supplemented by for example a large survey to be able to make broad generalization. In this circumstance we see the possibility of testing and comparing the importance of various categories of the Enterprise Modeling Practice model in relation to a variety of projects.

Due to limitations in our study we also see the need for various types of research approaches aiming at identifying all kinds of enterprise modeling initiatives. This can end in a classification system of different types of modeling initiatives and their expected benefits. We assume that a classification system of modeling initiatives with their corresponding benefits will be of value in discussions and decision-making on the use of modeling as part of ICT-enabled process change projects.

Future work should also focus on expanding the revised Enterprise Modeling Practice model by integrating the findings of more researchers, like for example quality aspects related to artifacts produced from the work of Persson (2001). An interesting possibility can be to address power structures between actors and the distribution of knowledge between project participants.

By supplementing the multiple case study with a single-case study we were able to describe modeling practice in four steps of process change. For each step we additionally presented the project managers recommendations and experiences. The single case study directly addressed a wish by Indulska et la (2009) on more case studies giving insights into both success and failure. Having investigated the Home Builder as a single case study, we share this wish for more case stories. In fact, after having followed the Home Builder for several years, we see that longitudinal case studies can provide unique insights which might be out of reach of many investigators or other research approaches. Such studies take time to conduct , being dependent on the willingness of the companies to participate in the research project by sharing time, experiences and various types of documentation from the process change process covering several years. Even though we tried to get as much information as possible in all cases, the Home Builder case stood out as unique by providing both board protocols, financial numbers and other more "classified" material necessary to paint a rather detailed picture of enterprise modeling practice. The depth of the material enabled us to recreate the change process to the extent that we could describe the use of enterprise modeling in relation to change steps performed along a time line. This is another perspective on enterprise modeling than what is focused in the Enterprise Modeling Practice model which concentrates on relationships between categories of context, modeling process and outcome.

Another outcome of the single case study was the recognition that both readiness and steps followed explain project success, where at the heart one finds enterprise modeling. Due to this finding we see the potential for and value of future research that aims to weight and compare the value of enterprise modeling against other factors, to see how such factors interact and influence project success both alone and in concert.

Having performed this study has strengthened our view that only by bringing together the work of different researchers, a holistic view of the intricate nature of enterprise modeling in practice can be made. From such a perspective we hope our work provides useful pieces in the puzzle for further empirical research on enterprise modeling.

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Appendix A – Matrices for latent analyses

To search our material for latent patterns, we produced a variety of different matrices, where OCHAR = Organizational characteristics, PSC = Project specific characteristics and PPC = Project participant characteristics constitute Context, EMP = Enterprise modeling practice and OUTC = Outcome/ Benefits. Each sub-category of context is matched against each subcategory of EMP and each sub-category of EMP is matched against Benefits of modeling, e.g. Outcome:

(1) OCHAR: Process maturity versus sub-categories of EMP: Table 1 to Table 8

(2) OCHAR: Modeling maturity versus sub-categories of EMP: Table 9 to Table 16

(3) OCHAR: Technological maturity versus sub-categories of EMP: Table 17 to Table 24

(4) PSC: Process change main focus versus sub-categories of EMP: Table 25 to Table 32

(5) PSC: ICT-initiative versus sub-categories of EMP: Table 33 to Table 40

(6) PSC: Project management/Systems development versus sub-categories of EMP: Table 41 to Table 48

(7) PSC: Moderators and Challenges versus sub-categories of EMP: Table 49 to Table 56

(8) PPC: Modeling expertise versus sub-categories of EMP: Table 57 to Table 64

(9) PPC: Process expertise versus sub-categories of EMP: Table 65 to Table 72

(10)PPC: Technological expertise versus sub-categories of EMP:
Table 73 to Table 80

(11) Sub-categories of EMP versus OUTC: Table 81 to 89

(1) OCHAR: Process maturity versus sub-categories of EMP

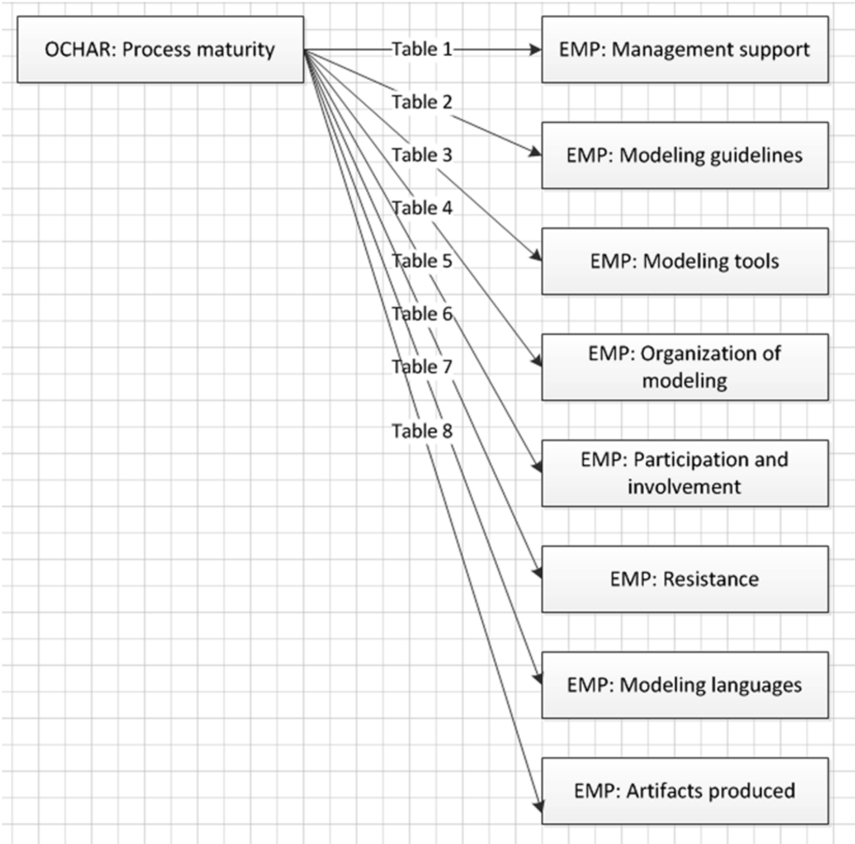

Table 1. Process maturity versus Management support

		Process maturity			
		Low	Medium	High	Varied
Management support	High, Inc.	C1,C5	C3		
	High	C2		C4,C6,C7	C8

Table 2. Process maturity versus Modeling Guidelines

		Process maturity			
		Low	Medium	High	Varied
Modeling guidelines	Varied	C1		C4	
	Had	C2,C5		C7	
	Had no		C3		C8
	Use of models			C6	

Table 3. Process maturity versus Modeling Tools

		Process maturity			
		Low	Medium	High	Varied
Modeling tools	Office	C1,C2,C5	C3	C4	
	Use of vendor supplied models			C6	
	Quality system app.			C7	
	No specific				C8

Table 4. Process maturity versus Organization of modeling (Karlsen and Opdahl, 2012b)

		Process maturity			
		Low	Medium	High	Varied
Organizatio n of modeling	Workshop with oral participation	C1,C2	C3	C4	C8
	Workshop with active participation			C7	
	Individual modeling	C5			
	Group based model use			C6	

Table 5. Process maturity versus Participation and involvement

Participation and involvement		Process maturity			
		Low	Medium	High	Varied
	High	C1,C2	C3	C6,C7	
	OK	C5		C4	
	Low				C8

Table 6. Process maturity versus Resistance

Resistance		Process maturity			
		Low	Medium	High	Varied
	Dec.	C1		C6,C7	
	Not present	C2, C5	C3	C4	
	Present				C8

Table 7. Process maturity versus Modeling languages

Modeling languages		Process maturity			
		Low	Medium	High	Varied
	Used	C2		C7	
	Not used	C1,C5	C3	C4,C6	C8

Table 8. Process maturity versus Artifacts produced

Artifacts produced		Process maturity			
		Low	Medium	High	Varied
	Process descriptions	C1,C2, C5	C3	C4,C7	C8
	Adapted	C1			
	Technical	C2,C5		C4	
	Meta models			C7	
	None			C6	

(2) OCHAR: Modeling maturity versus sub-categories of EMP

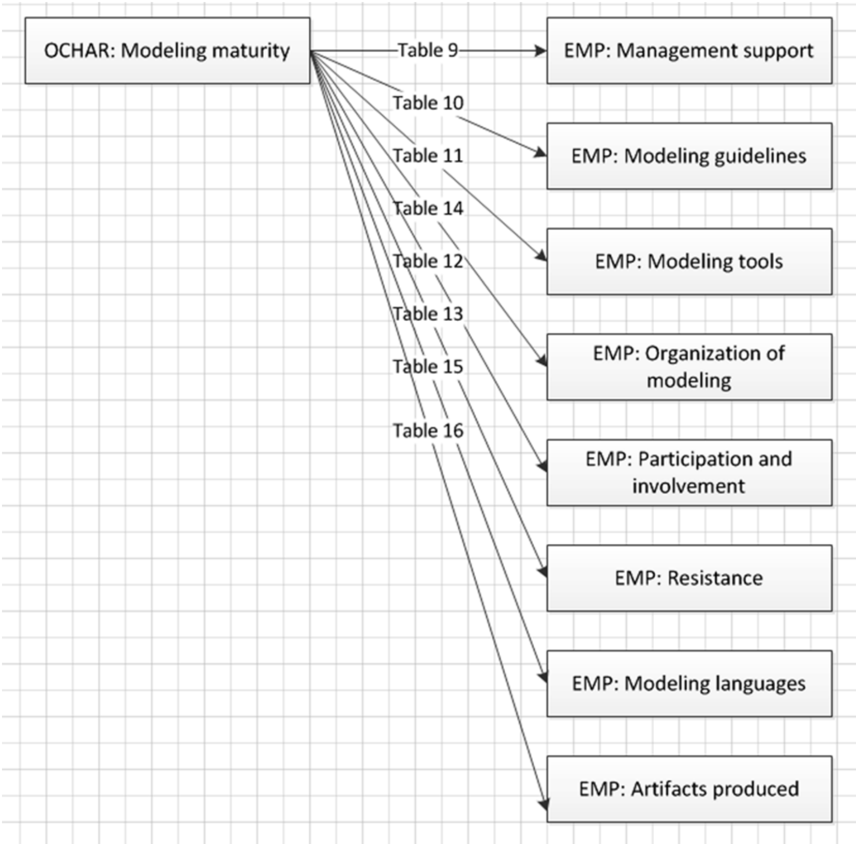

Table 9. Modeling maturity versus Management support

		Modeling maturity		
		Low	Medium_Low	High_ Varied
Management support	High, Inc.	C1,C3, C5		
	High	C2,C6	C4,C8	C7

Table 10. Modeling maturity versus Modeling Guidelines

		Modeling maturity		
		Low	Medium_Low	High_ Varied
Modeling guidelines	Varied	C1	C4	
	Had guidelines	C2, C5		C7
	Had no guidelines	C3	C8	
	Use of vendor supplied	C6		

Table 11. Modeling maturity versus Modeling Tools

		Modeling maturity		
		Low	Medium_Low	High_ Varied
Modeling tools	Office	C1,C2, C3,C5	C4	
	Use of vendor supplied	C6		
	Quality sys. application			C7
	No specific		C8	

Table 12. Modeling maturity versus Participation and Involvement

Participation and involvement		Modeling maturity		
		Low	Medium_Low	High_ Varied
	High	C1,C2, C3,C6		C7
	OK	C5	C4	
	Low		C8	

Table 13, Modeling maturity versus Resistance

Resistance		Modeling maturity		
		Low	Medium_Low	High_ Varied
	Dec.	C1,C6		C7
	None	C2, C3,C5	C4	
	Present		C8	

Table 14. Modeling maturity versus Organization of modeling activities

	Organizational modeling maturity:					
	External		Internal			
Organization of modeling activites:	High	Low	High	Low	Medium_Low	Variable
User forum	C7		C7			C7
Group-based model use		C6		C6		
Individual modeling	C2, C5, C8			C2, C5, C8	C8	
Supply your input	C7		C7			C7
Workshop with active participation	C7		C7			C7
Workshop with oral participation	C1, C2, C3, C4, C5, C8			C1, C2, C3, C4, C5, C8	C4, C8	

Table 15. Modeling maturity versus Modeling languages

		Modeling maturity		
		Low	Medium_Low	High_ Varied
Modeling languages	Used	C2		C7
	Not used	C1,C3, C5,C6	C4,C8	

Table 16. Modeling maturity versus Artifacts produced

		Modeling maturity		
		Low	Medium_Low	High_ Varied
Artifacts produced	Process descriptions	C1,C2,C3,C5	C4,C8	C7
	Adapted	C1		
	Technological	C2,C5	C4	
	Meta models			C7
	None	C6		

(3) OCHAR: Technological maturity versus sub-categories of EMP

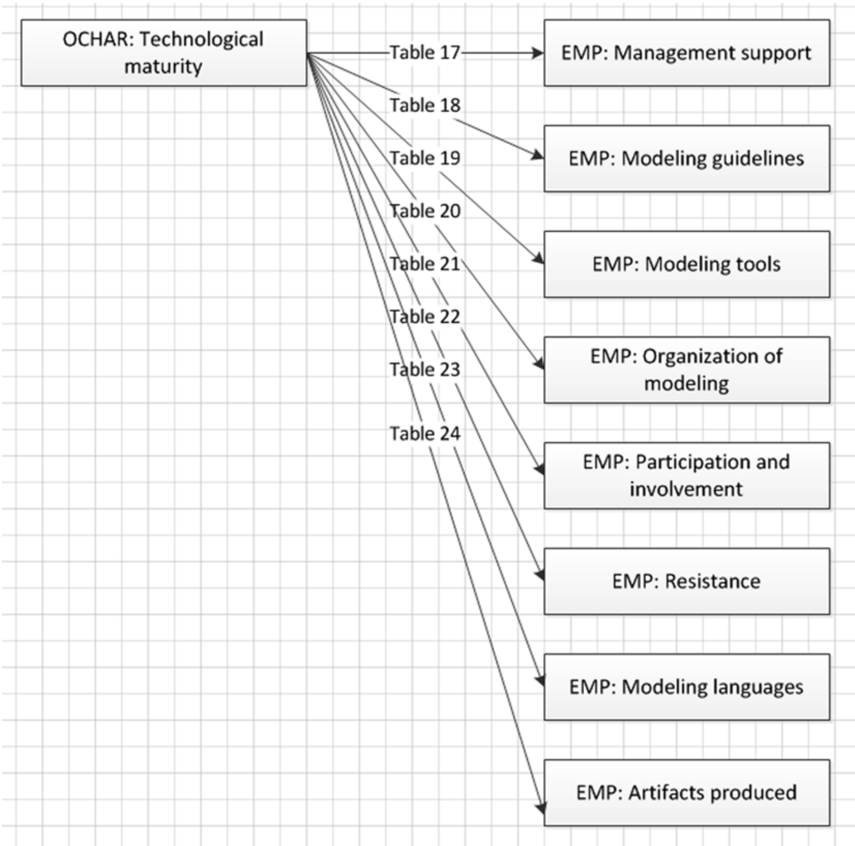

Table 17. Technological maturity versus Management support

		Technological maturity
		High
Management support	High, Inc.	C1,C3,C5
	High	C2,C4,C6,C7,C8

Table 18. Technological maturity versus Modeling Guidelines

Modeling Guidelines		Technological maturity
		High
	Varied	C1,C4
	Had	C2,C5,C7
	Had no	C3,C8
	Model use	C6

Table 19. Technological maturity versus Modeling Tools

Modeling tools		Technological maturity
		High
	Office	C1,C2,C3, C4,C5
	Vendor supplied	C6
	Quality system app.	C7
	No specific	C8

Table 20. Technological maturity versus Organization of modeling

Organization of modeling		Technological maturity
		High
	User forum	C7
	Group use	C6
	Individual	C5
	Supply your input	C7
	Workshop active	C7
	Workshop oral	C1,C2,C3,C4,C8

Table 21. Technological maturity versus Participation and involvement

Participation and involvement		Technological maturity: High
	High	C1,C2,C3,C6,C7
	OK	C4,C5
	Low	C8

Table 22. Technological maturity versus Resistance

Resistance		Technological maturity: High
	Dec.	C1,C6,C7
	Not present	C2,C3,C4,C5
	Present	C8

Table 23. Technological maturity versus Modeling languages

Modeling languages		Technological maturity: High
	Used	C2,C7
	Not used	C1,C3,C4,C5,C6,C8

Table 24. Technological maturity versus Artifacts produced

		Technological maturity
		High
Artifacts produced	Process descriptions	C1 to C8
	Adapted models	C1
	Tech. Models	C2,C4,C5
	Metamodels	C7
	None	C6

(4) PSC: Process change main focus versus sub-categories of EMP

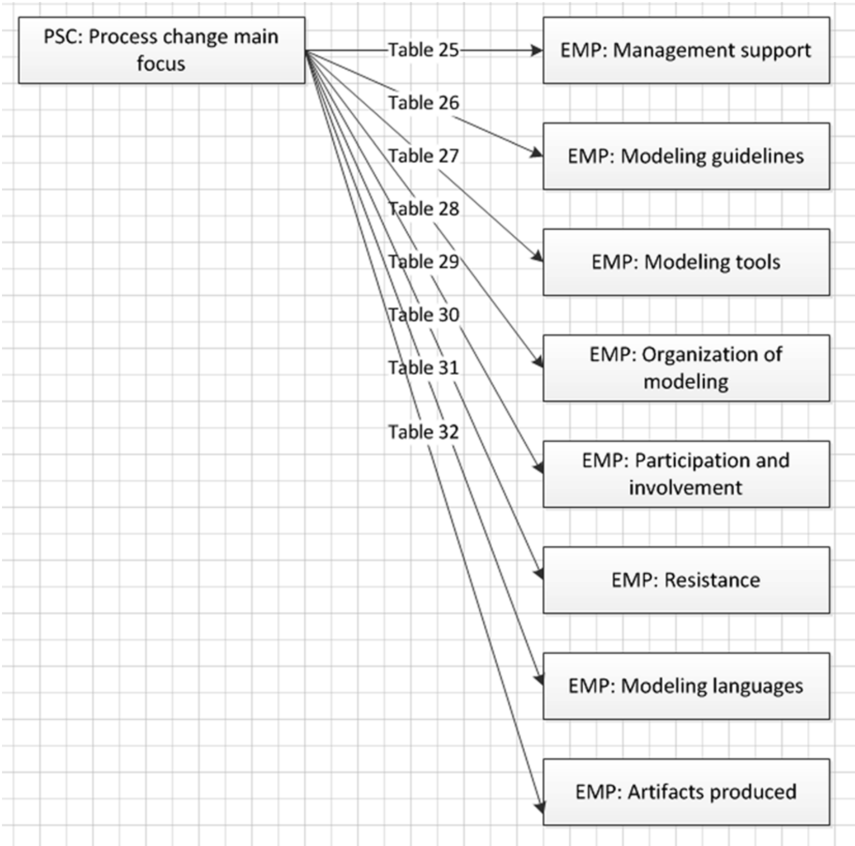

Table 25. Process change main focus versus Management Support

Management Support	Process change main focus		
	Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
High, Inc.	C1,C3,C5	C1,C3	
High	C2,C4,C7,C8	C2	C6,C7

Table 26. Process change main focus versus Modeling Guidelines

Modeling guidelines	Process change main focus		
	Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
Varied	C1,C4	C1	
Had	C2,C5,C7	C2	C7
Had no	C3,C8	C3	
Use of models			C6

Table 27. Process change main focus versus Modeling Tools

Modeling tools	Process change main focus		
	Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
Office	C1,C2,C3,C4,C5	C1,C2,C3	
Use of vendor supplied models			C6
Quality system application	C7		C7
No specific	C8		

Table 28. Process change main focus versus Organization of modeling

Organization of modeling	Process change main focus			
		Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
	User forum	C7		C7
	Group-based use			C6
	Individual	C5		
	Supply your input	C7		C7
	Workshop active	C7		C7
	Workshop oral	C8,C4	C1,C2,C3	

Table 29. Process change main focus versus Participation and Involvement

Participation and involvement	Process change main focus			
		Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
	High	C1,C2,C3,C7	C1,C2,C3	C6,C7
	OK	C4,C5		
	Low	C8		

Table 30. Process change main focus versus Resistance

Resistance		Process change main focus		
		Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
	Dec.	C1,C7	C1	C6,C7
	Not present	C2,C3,C4,C5	C2,C3	
	Present	C8		

Table 31. Process change main focus versus Modeling languages

Modeling languages		Process change main focus		
		Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
	Used	C2,C7	C2	C7
	Not used	C4	C1,C3	C6

Table 32. Process change main focus versus Artifacts produced

Artifacts produced		Process change main focus		
		Improving info. flow	Improving work practice by physical intervention	Improving work practice by technology
	Process descriptions	C1 to C5, C7,C8	C1 to C3	C7
	Adapted models	C1	C1	
	Tech. models	C2,C4,C5	C2	
	Metamodels	C7		C7
	None			C6

(5) PSC: ICT-initiative versus sub-categories of EMP

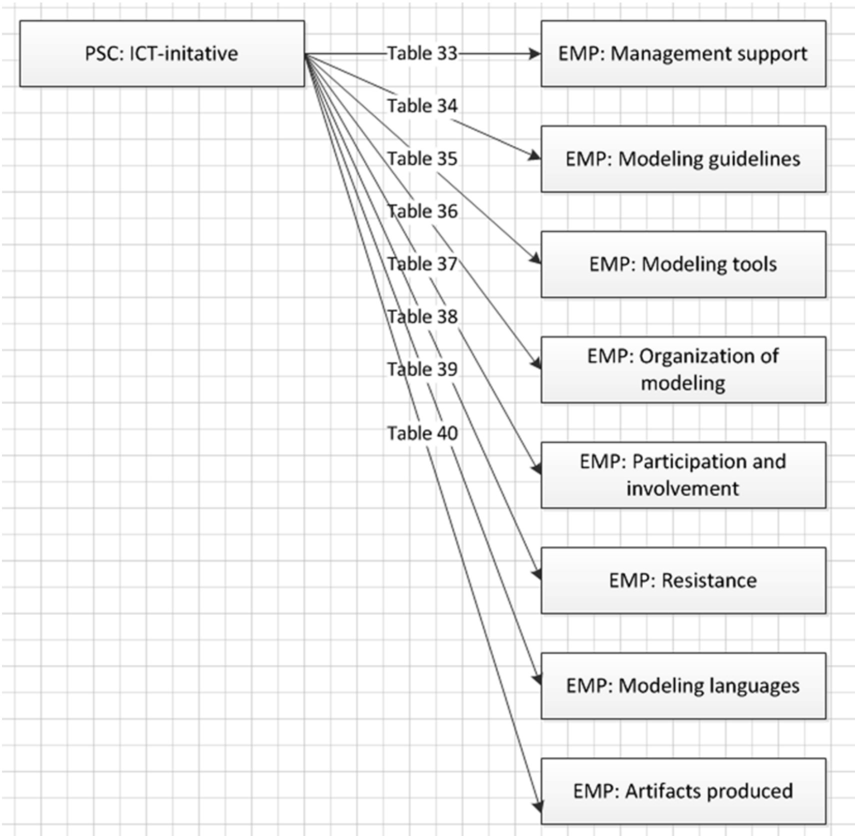

Table 33. ICT-initiative: ICT-based future solution versus Management Support

Management support	ICT-initiative: ICT-based future solution				
		Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
	High, Inc.	C1,C3,C5			
	High	C2,C4	C6	C7	C8

Table 34. ICT-initiative: ICT-based future solution versus Modeling Guidelines

Modeling guidelines	ICT-initiative: ICT-based future solution				
		Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
	Varied	C1,C4			
	Had	C2,C5		C7	
	Had no	C3			C8
	Use of models		C6		

Table 35. ICT-initiative: ICT-based future solution versus Modeling Tools

Modeling tools	ICT-initiative: ICT-based future solution				
		Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
	Office	C1 to C5			
	Use of vendor supplied models		C6		
	Quality system app.			C7	
	No specific				C8

Table 36. ICT-initiative: ICT-based future solution versus Organization of Modeling

Organization of modeling	ICT-initiative: ICT-based future solution				
		Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
	User forum			C7	
	Group-based use		C6		
	Individual	C5			
	Supply your input			C7	
	Workshop with active participation			C7	
	Workshop with passive participation	C1 to C4			C8

Table 37. ICT-initiative: ICT-based future solution versus Participation and Involvement

Participation and involvement	ICT-initiative: ICT-based future solution				
		Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
	High	C1,C2,C3	C6	C7	
	OK	C4,C5			
	Low				C8

Table 38. ICT-initiative: ICT-based future solution versus Resistance

Resistance	ICT-initiative: ICT-based future solution			
	Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
Resistance, dec.	C1	C6	C7	
Not present	C2,C3,C4,C5			
Present				C8

Table 39. ICT-initiative: ICT-based future solution versus Modeling languages

Modeling languages	ICT-initiative: ICT-based future solution			
	Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
Used	C2		C7	
Not used	C1,C3,C4,C5	C6		C8

Table 40. ICT-initiative: ICT-based future solution versus Artifacts produced

		ICT-initiative: ICT-based future solution			
		Standardized ERP solution	Wearable voice-directed warehouse application system	Quality system	Industry specific ERP solution
Artifacts produced	Process descriptions	C1 to C5		C7	
	Adapted model	C1			C8
	Tech models	C2,C4,C5			
	Metamodel			C7	
	None		C6		

(6) PSC: Project management/Systems development versus sub-categories of EMP

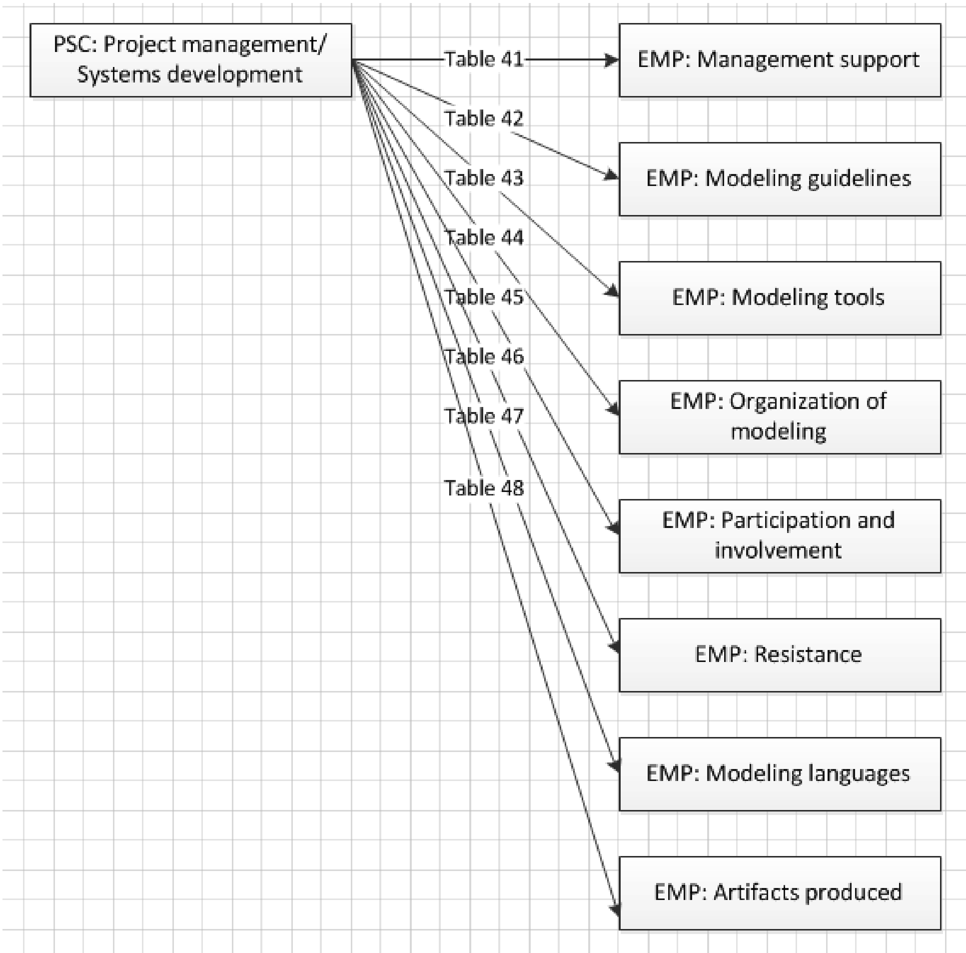

Table 41. Project management/Systems development versus Management support

Management support	Project management/Systems development				
		A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
	High, Inc.	C1	C3, C5		
	High		C2,C4,C8	C6	C7

Table 42. Project management/Systems development versus Modeling Guidelines

Modeling guidelines	Project management/Systems development				
		A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
	Varied	C1	C4		
	Had		C2,C5		C7
	Had no		C3,C8		
	Use of models			C6	

Table 43. Project management/Systems development versus Modeling Tools

Modeling guidelines	Project management/Systems development			
	A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
Office	C1	C2,C3,C4,C5		
Use of vendor supplied models			C6	
Quality system app.				C7
No specific		C8		

Table 44. Project management/Systems development versus Organization of modeling

Organization of modeling	Project management/Systems development			
	A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
User forum				C7
Group-based use			C6	
Individual		C5		
Supply your input				C7
Workshop with active participation				C7
Workshop with passive participation	C1	C2,C3,C4,C8		

Table 45. Project management/Systems development versus Participation and Involvement

		Project management/Systems development			
Participation and involvement		A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
	High	C1	C2,C3	C6	C7
	OK		C4,C5		
	Low		C8		

Table 46. Project management/Systems development versus Resistance

		Project management/Systems development			
Resistance		A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
	Resistance, dec.	C1		C6	C7
	Not present		C2,C3,C4,C5		
	Present		C8		

Table 47. Project management/Systems development versus Modeling languages

		Project management/Systems development			
Modeling		A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
	Used		C2		C7
	Not used	C1	C3,C4,C5,C8	C6	

Table 48. Project management/Systems development versus Artifacts produced

Artifacts produced	Project management/Systems development			
	A gradual year-long process	Standard	"..take a change that we can do so well, that we are able to see the consequences of what we do"	Pilot and launch
Process descriptions	C1	C3,C8		C7
Adapted models	C1	C2,C4,C5		
Tech. Models				
Metamodel				C7
None			C6	

(7) PSC: Moderators and Challenges versus sub-categories of EMP

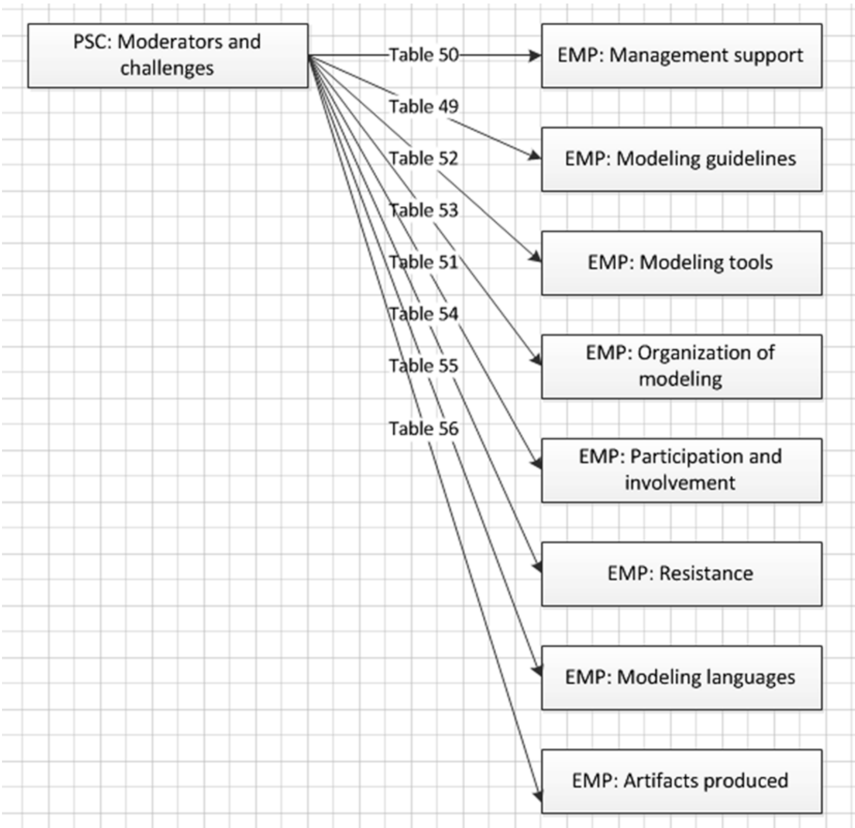

Table 49. Moderators and Challenges versus Modeling Guidelines

		Moderators and challenges					
		Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
Modeling Guidelines	Varied	C1	C4				
	Had	C2	C5		C7		C2
	Had no	C3,C8				C8	C8
	Use of models			C6			

Table 50. Moderators and Challenges versus Management Support

		Moderators and challenges					
		Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
Management support	High, inc.	C1,C3	C5				
	High	C2,C8	C4	C6	C7	C8	C2,C8

Table 51. Moderators and Challenges versus Participation and Involvement

Participation and involvement	Moderators and challenges					
	Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
High	C1,C2,C3		C6	C7		C2
OK		C4,C5				
Low	C8				C8	C8

Table 52. Moderators and Challenges versus Modeling Tools

Modeling tools	Moderators and challenges					
	Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
Office	C1,C2,C3	C4,C5				C2
Use of vendor supplied models			C6			
Quality sys. app.				C7		
No specific	C8				C8	C8

Table 53. Moderators and Challenges versus Organization of Modeling

Organization of modeling	Moderators and challenges					
	Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
User forum				C7		
Group based use			C6			
Individual		C5				
Supply your input				C7		
Workshop active participation				C7		
Workshop passive participation	C1,C2,C3,C8	C4			C8	C2,C8

Table 54. Moderators and Challenges versus Resistance

		Moderators and challenges					
Resistance		Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
	Dec.	C1		C6	C7		
	Not present	C2,C3	C4,C5				C2
	Present	C8				C8	C8

Table 55. Moderators and Challenges versus Modeling languages

		Moderators and challenges					
Modeling languages		Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
	Used	C2			C7		C2
	Not used	C1,C3,C8	C4,C5	C6		C8	C8

Table 56. Moderators and Challenges versus Artifacts produced

		Moderators and challenges					
		Resource specific issues	No	Project participant characteristics	Time	IT-system issues	Information issues
Artifacts produced	Process descriptions	C1,C2,C3,C8	C4,C5		C7	C8	C2,C8
	Adapted models	C1					
	Tech. models	C2	C4,C5				C2
	Meta models				C7		
	None			C6			

(8) PPC: Modeling expertise versus sub-categories of EMP

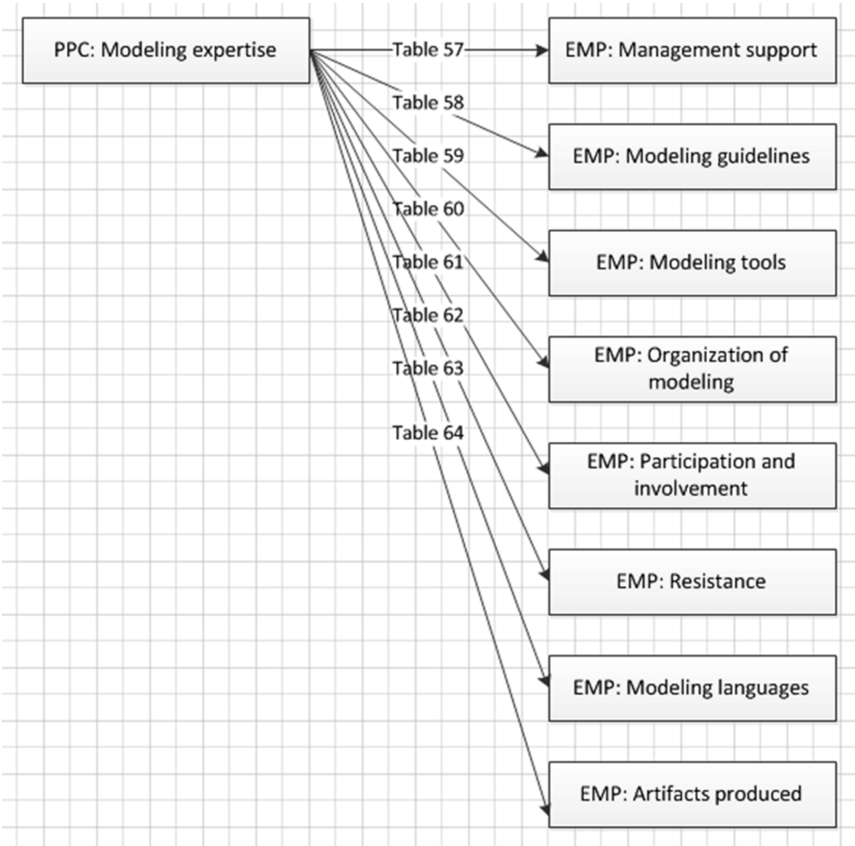

Table 57. Modeling expertise versus Management Support

Management Support		Modeling expertise		
		Low	High_Medium	High
	High, inc.		C1,C3,C5	
	High	C6	C2,C4,C8	C7

Table 58. Modeling expertise versus Modeling Guidelines

Modeling Guidelines		Modeling expertise		
		Low	High_Medium	High
	Varied		C1,C4	
	Had		C2,C5	C7
	Had no		C3,C8	
	Use of models	C6		

Table 59. Modeling expertise versus Modeling Tools

Modeling tools		Modeling expertise		
		Low	High_Medium	High
	Office		C1,C2,C3,C4,C5,C8	
	Use of vendor supplied	C6		
	Quality system app.			C7
	No specific		C8	

Table 60. Modeling expertise versus Organization of Modeling

Organization of Modeling		Modeling expertise		
		Low	High_Medium	High
	User forum			C7
	Group-based use	C6		
	Individual		C5	
	Supply your input			C7
	Workshop active			C7
	Workshop oral		C1,C2,C3,C4,C8	

Table 61. Modeling expertise versus Participation and Involvement

Participation and Involvement		Modeling expertise		
		Low	High_Medium	High
	High,	C6	C1,C2,C3	C7
	OK		C4,C5	
	Low		C8	

Table 62. Modeling expertise versus Resistance

Resistance		Modeling expertise		
		Low	High_Medium	High
	Dec.	C6	C1, C6	C7
	Not present		C2,C3,C4,C5	
	Present		C8	

Table 63. Modeling expertise versus Modeling languages

Modeling languages		Modeling expertise		
		Low	High_Medium	High
	Used		C2	C7
	Not used	C6	C1,C3,C4,C5,C8	

Table 64. Modeling expertise versus Artifacts produced

Artifacts produced		Modeling expertise		
		Low	High_Medium	High
	Process descriptions		C1,C2,C3, C4,C5,C8	
	Adapted models		C1	
	Tech. models		C2,C4,C5	
	Meta models			C7
	None	C6		

(9) PPC: Process expertise versus sub-categories of EMP

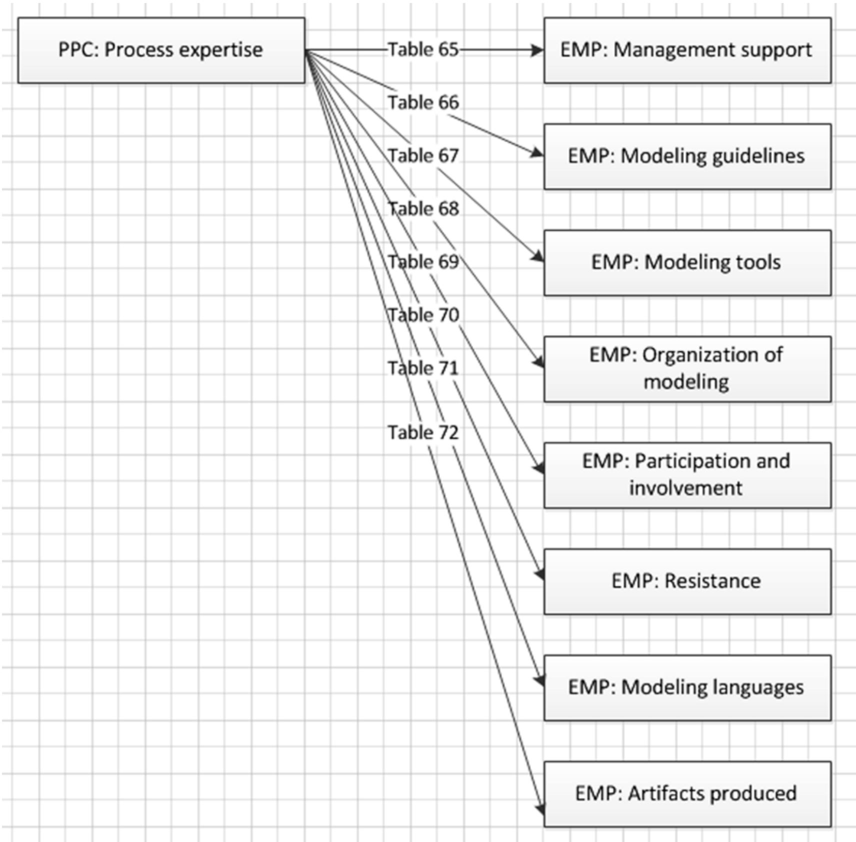

Table 65. Process expertise versus Management Support

		Process expertise
Modeling languages		High
	High, Inc.	C1,C3,C5
	High	C2,C4,C6,C7,C8

Table 66. Process expertise versus Modeling Guidelines

		Process expertise
Modeling guidelines		High
	Varied	C1, C4
	Had	C2, C5, C7
	Had no	C3, C8
	Use of models	C6

Table 67. Process expertise versus Modeling Tools

		Process expertise
		High
Modeling tools	Office	C1,C2,C3,C4,C5
	Use of vendor supplied models	C6
	Quality system app.	C7
	No specific	C8

Table 68. Process expertise versus Organization of Modeling

		Process expertise
		High
Organization of modeling	User forum	C7
	Group-based model use	C6
	Individual	C5
	Supply your input	C7
	Workshop active	C7
	Workshop oral	C1,C2,C3,C4,C8

Table 69. Process expertise versus Participation and Involvement

		Process expertise
		High
Participation and involvement	High	C1,C2,C3,C6,C7
	OK	C4,C5
	Low	C8

Table 70. Process expertise versus Resistance

		Process expertise
		High
Resistance	Resistance, dec.	C1, C6,C7
	Not present	C2, C3,C4,C5
	Present	C8

Table 71. Process expertise versus Modeling languages

		Process expertise
		High
Modeling languages	Used	C2,C7
	Not used	C1,C3,C4,C5,C6, C8

Table 72. Process expertise versus Artifacts produced

		Process expertise
		High
Artifacts produced	Process descriptions	C1, C2, C3,C4,C5,C7,C8
	Adapted models	C1
	Tech. models	C2,C4,C5
	Metamodels	C7
	None	C6

(10) PPC: Technological expertise versus sub-categories of EMP

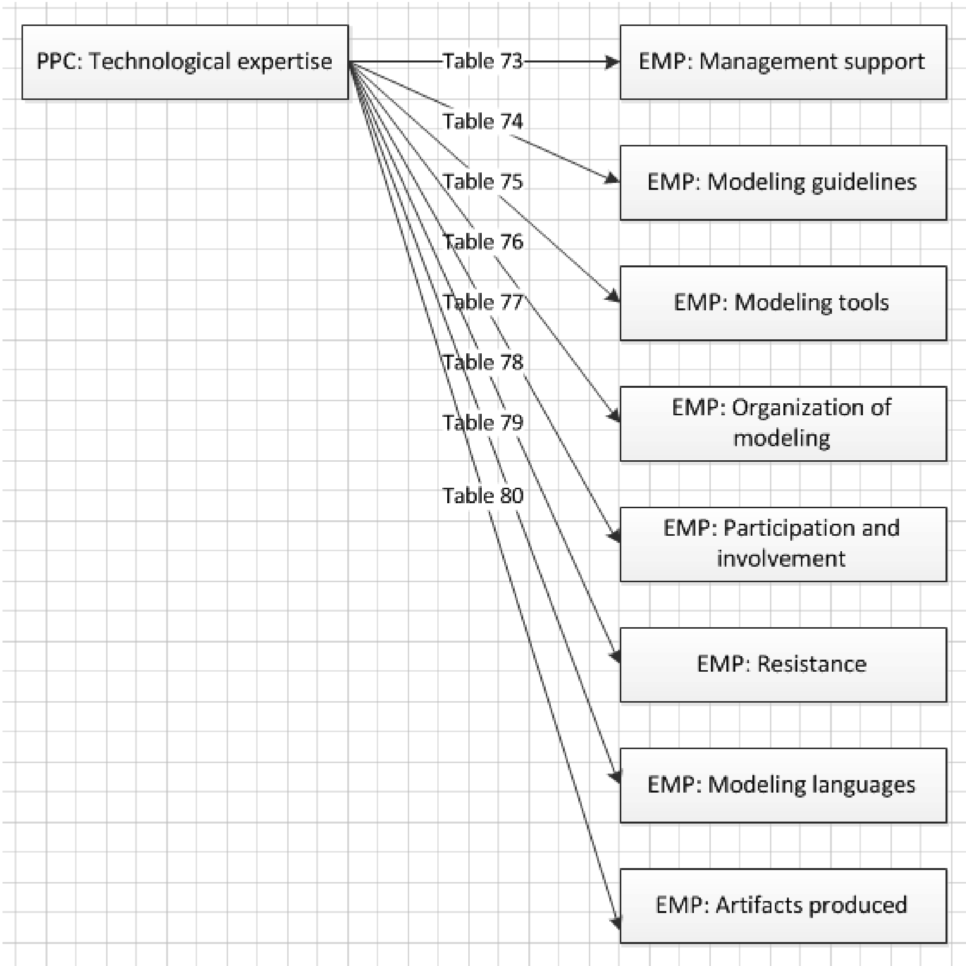

Table 73. Technological expertise versus Management Support

		Technological expertise
		High
Management support	High, Inc.	C1,C3,C5
	High	C2, C4,C6,C7,C8

Table 74. Technological expertise versus Modeling Guidelines

		Technological expertise
		High
Modeling guidelines	Varied	C1,C4
	Had	C2,C5,C7
	Had no	C3,C8
	Use of models	C6

Table 75. Technological expertise versus Modeling Tools

		Technological expertise
		High
Modeling tools	Office	C1, C2,C3,C4,C5
	Use of vendor supplied models	C6
	Quality system app.	C7
	No specific	C8

Table 76. Technological expertise versus Organization of Modeling

		Technological expertise
		High
Organization of modeling	User forum	C7
	Group-based model use	C6
	Individual	C5
	Supply your input	C7
	Workshop active	C7
	Workshop oral	C1,C2,C3,C4,C8

Table 77. Technological expertise versus Participation and Involvement

		Technological expertise
		High
Participation and involvement	High	C1, C2,C3,C6,C7
	OK	C4, C5
	Low	C8

Table 78. Technological expertise versus Resistance

		Technological expertise
		High
Resistance	Resistance, dec.	C1, C6,C7
	Not present	C2, C3, C4, C5
	Present	C8

Table 79. Technological expertise versus Modeling languages

		Technological expertise
		High
Modeling languages	Used	C2, C7
	Not used	C1, C3, C4, C5,C6,C8

Table 80. Technological expertise versus Artifacts produced

		Technological expertise
		High
Artifacts produced	Process descriptions	C1,C2,C3,C4, C5,C7,C8
	Adapted models	C1
	Tech. models	C2,C4,C5
	Meta models	C7
	None	C6

(11) Sub-categories of EMP versus OUTC

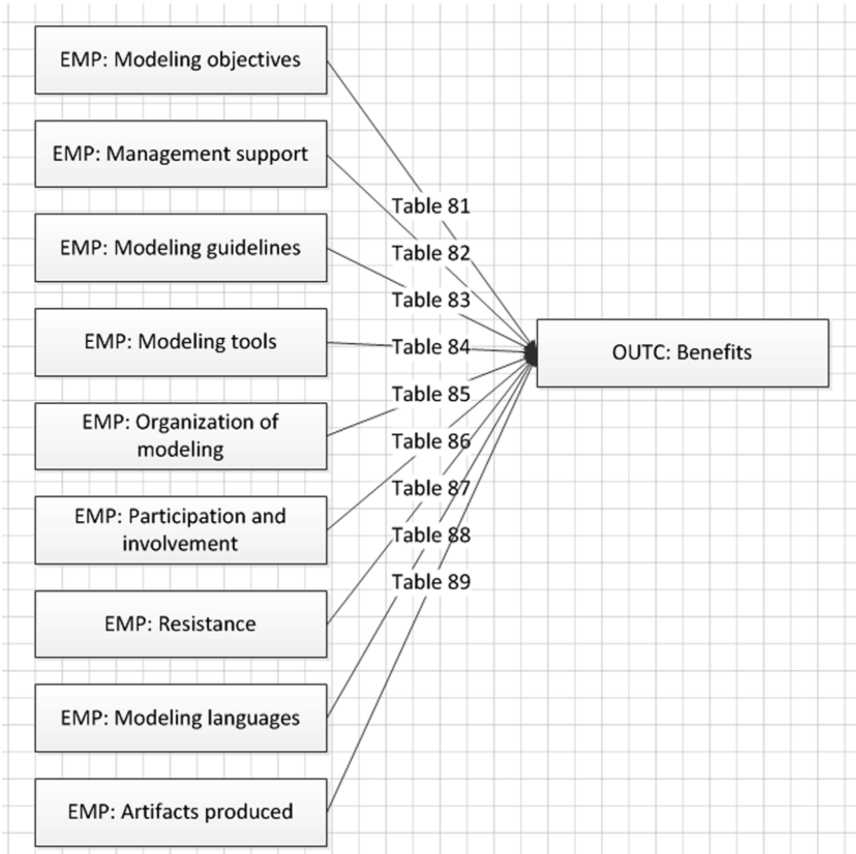

Table 81. Modeling objectives versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Modeling objective I				Modeling to reveal AS-IS	Modeling to reveal AS-IS			Modeling to reveal build-up of applications
Modeling objective II	Modeling to reach a LEAN strategy	Modeling to reach a growth strategy	Modeling to reach a LEAN strategy	Modeling as input to a demand specification	Modeling as input to a demand specification	Model use to reveal differences between org and system	Modeling to fill a quality system with process descriptions	Modeling as input to preliminary report
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
				Modeling objectives				
			Modeling to reach a strategy	Modeling as input to a demand specification and to reveal AS-IS	Model use to reveal differences between org and system	Modeling to fill a quality system	Modeling to reveal buil-up of appication and as input to report	
		APC	C1,C2,C3	C4, C5	C6	C7	C8	*C1,C2,C3,C4,C5,C6,C7*
	Benefits	Organizational	C1,C2,C3		C6			*C1,C2,C3,C6,C8*
		Project related	C1,C2,C3	C4, C5	C6		C8	*C1,C2,C3,C4,C5,C6,C8*
		Technological	C1,C2,C3	C4, C5	C6		C8	*C1,C2,C3,C4,C5,C6,C8*
		QS related				C7		*C7*
			C1,C2,C3	*C4, C5*	*C6*	*C7*	*C8*	

Table 82. Management Support versus Benefits (Karlsen and Opdahl, 2012b)

Case	C1	C2	C3	C4	C5	C6	C7	C8
Management support	High; Inc.; Crucial	High; Crucial	High; Inc.	High	High; Inc.	High	High;Crucial	High; One of the leading yards motivated the project
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
			Management support					
			High; Inc.	High; Crucial				
		APC	C1,C3,C5	C2,C4,C6,C7	C1,C2,C3,C4,C5,C6,C7			
	Benefits	Organizational	C1,C3	C2,C6,C8	C1,C2,C3,C6,C8			
		Project related	C1,C3,C5	C2,C4,C6,C8	C1,C2,C3,C4,C5,C6,C8			
		Technological	C1,C3,C5	C2,C4,C6,C8	C1,C2,C3,C4,C5,C6,C8			
		QS related		C7	C7			
			C1, C3,C5	C2,C4,C6,C7,C8				

Table 83. Modeling Guidelines versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Modeling Guidelines	Had guidelines/Had no concrete guidelines	Had guidelines	Had no concrete guidelines	Had guidelines/Had no concrete guidelines	Had guidelines	Use of vendor supplied models	Had guidelines	Had no concrete guidelines
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
				Modeling guidelines				
			Varied	Had guidelines	Had no guidelines	Use of models		
	Benefits	APC	C1, C4	C2, C5,C7	C3	C6	*C1,C2,C3,C4,C5,C6,C7*	
		Organizational	C1	C2	C3,C8	C6	*C1,C2,C3,C6,C8*	
		Project related	C1,C4	C2, C5	C3, C8	C6	*C1,C2,C3,C4,C5,C6,C8*	
		Technological	C1, C4	C2,C5	C3,C8	C6	*C1,C2,C3,C4,C5,C6,C8*	
		QS related		C7			*C7*	
			C1, C4	*C2, C5,C7*	*C3, C8*	*C6*		

Table 84. Modeling Tools versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Modeling Tools	Word & Excel	Visio, PPT & Excel	Word	Word	PPT	Use of vendor supplied models	Quality system application	No specific
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
			Modeling tools					
			Office	Use of models	Quality system	No specific		
	Benefits	APC	C1,C2,C3,C4,C5	C6	C7		C1,C2,C3,C4,C5,C6,C7	
		Organizational	C1,C2,C3	C6		C8	C1,C2,C3,C6,C8	
		Project related	C1,C2,C3,C4,C5	C6		C8	C1,C2,C3,C4,C5,C6,C8	
		Technological	C1,C2,C3,C4,C5	C6		C8	C1,C2,C3,C4,C5,C6,C8	
		QS related			C7		C7	
			C1,C2,C3,C4,C5	C6	C7	C8		

Table 85. Organization of Modeling versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8		
Organization of modeling (Initial: Individual modeling or workshop)	Workshops with oral participation	Workshops with oral participation	Workshops with oral particiaption	Workshops with oral participation	Individual modeling; the consultant made the models to reach his job objective	Group-based model use of vendor supplied models	Workshops with active participation	Workshops with oral participation. Individual modelling		
Benefit type I	APC	APC	APC	APC	APC	APC	APC			
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational		
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related		
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological		
Benefit type V							QS related			
					Organization of modeling					
			User forum	Group-based use	Individual	Supply your input	Workshops active	Workshop oral		
	Benefits	APC	C7	C6	C5	C7	C7	C1,C2,C3,C4	C1,C2,C3,C4,C5,C6,C7	
		Organizational		C6				C1,C2,C3	C1,C2,C3,C6,C8	
		Project related		C6	C5			C1,C2,C3,C4	C1,C2,C3,C4,C5,C6,C8	
		Technological		C6	C5			C1,C2,C3,C4	C1,C2,C3,C4,C5,C6,C8	
		QS related	C7			C7	C7		C7	
			C7	C6	C5	C7	C7	C1,C2,C3,C4		

Table 86. Participation and Involvement versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Participation and involvement	High	High	High	OK	OK; but could have been better	High; demanded that everyone had to be active	High; demanded that everyone had to be active	Low; often the ability to contribute is low
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
			Participation and involvement					
			Low	OK	High			
	Benefits	APC		C4, C5 (Dataflow)	C1,C2,C3 (Strategy)	C6 (Work), C7 (Support)	C1,C2,C3,C4,C5,C6,C7	
		Organizational	C8 (Industry)		C1,C2,C3 (Strategy)	C6 (Work)	C1,C2,C3,C6,C8	
		Project related	C8 (Industry)	C4, C5 (Dataflow)	C1,C2,C3 (Strategy)	C6 (Work)	C1,C2,C3,C4,C5,C6,C8	
		Technological	C8 (Industry)	C4, C5 (Dataflow)	C1,C2,C3 (Strategy)	C6 (Work)	C1,C2,C3,C4,C5,C6,C8	
		QS related			C7 (Support)		C7	
			C8	C4, C5	C1,C2,C3,C6,C7			

Table 87. Resistance versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Resistance	Resistance; dec.	Not present	Not present	Not present	Not present	Resistance; dec.	Resistance; dec.; Challenges associated with understanding graphical images	Resistance present
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
			Resistance					
			Resistance dec.	Not present	Resistance present			
	Benefits	APC	C1,C6,C7	C2,C3,C4,C5		C1,C2,C3,C4,C5,C6,C7		
		Organizational	C1,C6	C2,C3	C8	C1,C2,C3,C6,C8		
		Project related	C1,C6	C2,C3,C4,C5	C8	C1,C2,C3,C4,C5,C6,C8		
		Technological	C1,C6	C2,C3,C4,C5	C8	C1,C2,C3,C4,C5,C6,C8		
		QS related	C7			C7		
			C1,C6,C7	C2,C3,C4,C5	C8			

Table 88. Modeling languages versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Modeling languages	Not used	Used	Not used	Not used	Not used	Not used	Used	Not used
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
			Modeling languages					
			Not used	Used				
	Benefits	APC	C1, C3,C4,C5,C6	C2, C7	C1,C2,C3,C4,C5,C6,C7			
		Organizational	C1,C3,C6,C8	C2	C1,C2,C3,C6,C8			
		Project related	C1, C3,C4,C5,C6,C8	C2	C1,C2,C3,C4,C5,C6,C8			
		Technological	C1, C3,C4,C5,C6,C8	C2	C1,C2,C3,C4,C5,C6,C8			
		QS related		C7	C7			
			C1, C3,C4,C5,C6,C8	C2,C7				

Table 89. Artifacts produced versus Benefits

Case	C1	C2	C3	C4	C5	C6	C7	C8
Artifacts produced	Process descriptions; Adapted models	Process descriptions; Org. Charts; Tech. Models	Process descriptions	Process descriptions; Tech. Models	Process descriptions Tech. Models	None	Process descriptions; Meta models	Process descriptions
Benefit type I	APC	APC	APC	APC	APC	APC	APC	
Benefit type II	Organizational	Organizational	Organizational			Organizational		Organizational
Benefit type III	Project related	Project related	Project related	Project related	Project related	Project related		Project related
Benefit type IV	Technological	Technological	Technological	Technological	Technological	Technological		Technological
Benefit type V							QS related	
				Artifacts produced				
			Adapted models	Process descriptions	None	Tech. Models	Meta models	
	Benefits	APC	C1	C1, C2,C3,C4,C5,C7	C6	C2, C4,C5	C7	C1,C2,C3,C4,C5,C6,C7
		Organizational	C1	C1,C2,C3,C8	C6	C2		C1,C2,C3,C6,C8
		Project related	C1	C1,C2,C2,C4,C5,C8	C6	C2,C4,C5		C1,C2,C3,C4,C5,C6,C8
		Technological	C1	C1,C2,C2,C4,C5,C8	C6	C2,C4,C5		C1,C2,C3,C4,C5,C6,C8
		QS related		C7			C7	C7
			C1	C1, C2,C3,C4,C5,C7,C8	C6	C2, C4,C5	C7	

Appendix 2 - Publications

I

A Research Model for Enterprise Modeling in ICT-enabled Process change

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Abstract. There are few empirical studies and accompanying models of enterprise modeling practice in information and communication technology (ICT) enabled process change. This paper presents an enterprise modeling research model to be used in a project investigating the use of enterprise modeling in ICT-enabled process change in Norwegian west coast enterprises. The model and its implications should be of interest to anyone involved in practical process change projects. The model incorporates and builds on categories and subcategories in the Process Modeling Practice (PMP) model, existing literature and contemporary research findings drawn from the PMP study and a pilot study of a corporate merger case.

Keywords: ICT-enabled process change, the PMP model, enterprise modeling practice.

1 Introduction

According to Persson and Stirna [16], research concerning enterprise modeling practice has been more or less neglected by the research community; instead focusing on the development of enterprise modeling methods. This matches the situation concerning research into process modeling practice, as emphasized in relation to a study by Eikebrokk et al.[4,25] named the Process Modelling Practice (PMP) study.

In this paper an Enterprise Modeling Practice (EMP) research model is presented, showing possible categories influencing and being influenced by enterprise modeling. Besides being a research model for this particular project, the EMP model exhibits key factors of importance and interest to anyone engaged in practical ICT enabled process change. The model will be used in a study, the EMP study, of enterprise modeling use in information and communication technology (ICT) enabled process change in enterprises on the west coast of Norway. The EMP study is initiated to supplement the PMP study in an effort to contribute towards a theory of model-based process change. Through reviewing literature on the field, the EMP model is derived from compiling different views and findings from a variety of sources.

Both in the ICT industry and in and between enterprises implementing new ICT systems to facilitate processes [2,3,7,13,18,19] one faces challenges. Statements emphasize that a large part of implementation failures are related to insufficient alignment between various aspects or parts of an organization and the new technology [14, 24]. Henderson [1, p.xiii] says that “emphasis on modeling is well chosen because it is shared models of systems that will lead to the common understanding on which rapid progress can be made”. The acknowledgement of this view can be seen through the development of different enterprise architectures that has emerged over the past decade; the Zachman Framework for Enterprise Architecture, DoDAF, PERA, CIMOSA, ARIS and GERAM, to mention just a few. In addition, several commercial computer tools have come into the marketplace in recent years to assist with architecture visualization and modeling.

2 Theory

2.1 Enterprise modeling

Enterprise modeling (EM) is concerned with representing the structure, organization and behavior of a business entity [28], i.e., a part of an enterprise, a group of enterprises cooperating, the whole enterprise or just single processes in the value chain, to evaluate its performances or reengineer its material, information or control flows in order to make it more efficient [28,23].

Vernadat [22] defines EM as the set of activities or processes used to develop the various parts of an enterprise model to address some modeling finality, whereas an enterprise model is a consistent set of special-purpose and complementary models describing the various facets of an enterprise to satisfy some purpose of some business users. In this way an enterprise model is not one monolithic model, but an assemblage of models [23], for example organization models, process models, data models, configuration models and plant layout models [28].

According to Vernadat [22] an enterprise model "…already exists in any company, be it small or large. The problem is that in nearly all cases it is poorly formalized. It exists in the form of organization charts established by management, documented operational procedures, regulation texts, and to a large extent in the vast amount of enterprise data (either in databases, knowledge bases, or simply data files) and code of application programs. However, a large part remains in the mind of enterprise people and is not formalized or even documented at all". [22, p.70]. Supporting this view, Kalpic & Bernus [10] say that it is a well known fact that much of the existing extremely valuable information and knowledge in enterprises is not made explicit, externalized or formalized and is consequently not available for use by other individuals, and sometimes even can be lost for the enterprises.

According to Miller & Berger [14], enterprise views such as the executive leadership view, the processes view, resources view and processes view relate to each other in general, thus giving rise to questions concerning the who, what, where, when, why and how of enterprise which must be answered simultaneously; all views act as constraints on the others. The making of different enterprise models gives us the possibility to see and discuss how the different parts (the ICT system, the processes, etc.) are interconnected and interplay. Understanding means not only knowing what elements the enterprise consists of and how they are related from different aspects, but also how the elements work together in the enterprise as a whole [11]. "Trying to answer all of the questions from a single viewpoint is like trying to explain what an entire house and its contents are by looking through a single window; it seldom provides a complete and accurate answer" [14, p.52]. Following this, when using EM in relation to ICT-enabled process change, different stakeholders like ICT specialists, managers, users etc. have a tool, a set of models that might enable them to discuss status quo and future possibilities concerning process changes and their technological implications in a more holistic way. For example they can see how changes in a business process might imply necessary changes in the enterprise ICT systems or how the implementation of an enterprise resource planning (ERP) solution likely results in the need for major changes in business processes. Combining this insight with information about the enterprise vision, values, mission and goals, the different stakeholders get broader perspectives and knowledge about how the parts relate to each other and which framework one has to work within when planning or doing structural changes in processes enabled by ICT. The latter is connected to the special role of the executive leadership view whereby all activities and organizations in the enterprise must somehow align to and sustain.

2.2 ICT-enabled process change

Today, we see both localized exploitation and internal integration of ICT, together with business process redesign, business network redesign, and business scope redefinition. The consequences of ICT on the design of processes can be summarized as [6,5]:

- elimination of human work from the structured process through automation
- change of the sequence of activities and simultaneous working
- gathering of process information
- integration of tasks leading to the coordination of parts and tasks
- object orientation with the effect of tracking the status of process and work
- optimized analysis increasing the possibilities of analyzing information and decision making
- elimination of interfaces with the effect of reducing critical interdependences in processes
- the overcoming of geographic distances resulting in wide area coordination of processes

Information system (IS) development methodologies are largely dominated by a functionalist perspective, that is, how to produce functionally correct and efficient user requirements, as a basis for system specifications. ICT-enabled process change calls for IS development methodologies whereby the development of computer systems is perceived as an organizational issue, in the tradition of sosio-technical systems thinking if one follows Munkvold [17] stating that the development and implementation of information systems can be seen as a special form of organizational change activity and that the mutual relationship between organizations and information technology makes this process sosio-technical "by nature". The goal according to the socio-technical perspective is joint optimization of the social and technical systems in an organization [17]. Optimization of one of the systems at the expense of the other will only result in sub-optimal solutions. Therefore all organizational design processes should also focus on the quality of work life of the employees, the latter making it important that different stakeholders participate in the design process since it is believed that decisions regarding the specification of work are best made by those who actually perform the tasks [17].

The MUST method for participatory design is an example of a methodological development that has clear link to the socio-technical perspective which speaks for itself concerning enterprise models as ‘natural ingredients’ when developing an IS. It is based on the principles of participation, close links to project management, design as a communication process, combining ethnography and intervention, co-development of ICT, work organization and users’ qualifications and sustainability [17]. The method includes management issues in relation to design processes in an organizational context; something that should be highly valuable considering McAfee’s reality description: “Managers I’ve worked with admit privately that success with ICT requires their commitment, but they’re not clear where, when, and how they should get involved. That’s partly because executives usually operate without a comprehensive model of what ICT does for companies, how it can affect organizations, and what managers must do to ensure that ICT initiatives succeed” [13, p.142].

2.3 The PMP model

Iden, Eikebrokk, Olsen & Opdahl [9, 4] emphasize that process change, in various incarnations, has been a central topic in the IS field for several decades. Through their study, named the process-modeling practice (PMP) study, based on in-depth interviews of 33 informants, each describing a different process-change effort in one of 30 Norwegian enterprises, they give insight into Norwegian model-supported process-change practice, focusing especially on process modeling.

The PMP study is one of few empirical studies concerning process-modeling practice. As part of their study they introduce the PMP model which outlines factors influencing the modeling process. The following figure shows the PMP model used in their study:

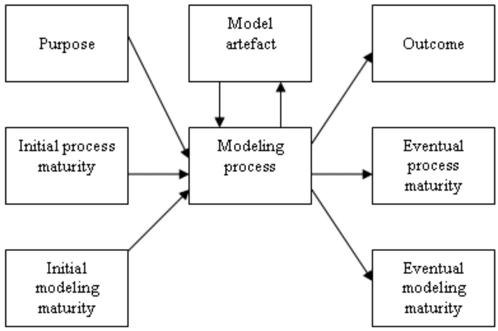

Fig. 1. The PMP model

The PMP model indicates that characteristics of the organization (process and modeling maturity) have influence on the modeling process. Furthermore, the model shows that the purpose of modeling as well as the artifacts available influence on the modeling process. Particularly interesting is the suggestion that the modeling process has an outcome not only relevant for the process *per se*, but influence the organization as a whole in form of eventual process maturity and modeling maturity.

As a motivation to why one should be occupied with modeling in projects, it can be mentioned that quantitative and qualitative analysis in the PMP study shows that high-outcome projects tend to have highly complex modeling processes, whereas middle- and low-outcome projects follow simpler processes. Qualitative analysis also indicates that high-outcome projects use more complex model artifacts than middle- and low-outcome projects.

3 The EMP research model

To conduct a study especially related to ICT-enabled process change projects the EMP model has been developed to be used as a tool in further work. In this section the EMP model is presented. The model incorporates and builds upon the categories and subcategories found in the PMP model [4,25], findings from the PMP study, aspects found in literature, especially in relation to the writings of Davenport [5] and

Sedera et al. [20], and a pilot study of a corporate merger. The pilot study is given a short description in section 4, whilst in section 5 the PMP and the EMP study are compared and discussed. Figure 2 shows the enterprise-modeling practice (EMP) model that has been developed.

The three main categories in the EMP model. The three main categories in the model are Enterprise modeling (EM), Context and Outcome.

Enterprise modeling (EM). EM is defined as the set of activities or processes used to develop the various parts of an enterprise model to address some modeling finality in accordance with Vernadat [22]. This category is the focal point of study; it addresses both the development of new models and the additional usage of existing models in relation to the ICT-enabled process change project. It includes both the usage and making of formalized and non-formalized models, this latter being of interest in accordance with Vernadat [22] saying that to a large extent, models are in the mind of the enterprise people; not being formalized or documented at all. In cases where the enterprise models are just part of the individuals' minds, one should expect that the ability to share insight is reduced, thus giving rise to a sub-optimal ICT-enabled process change solution.

EM is further elaborated by sub-categories as shown in table 1.

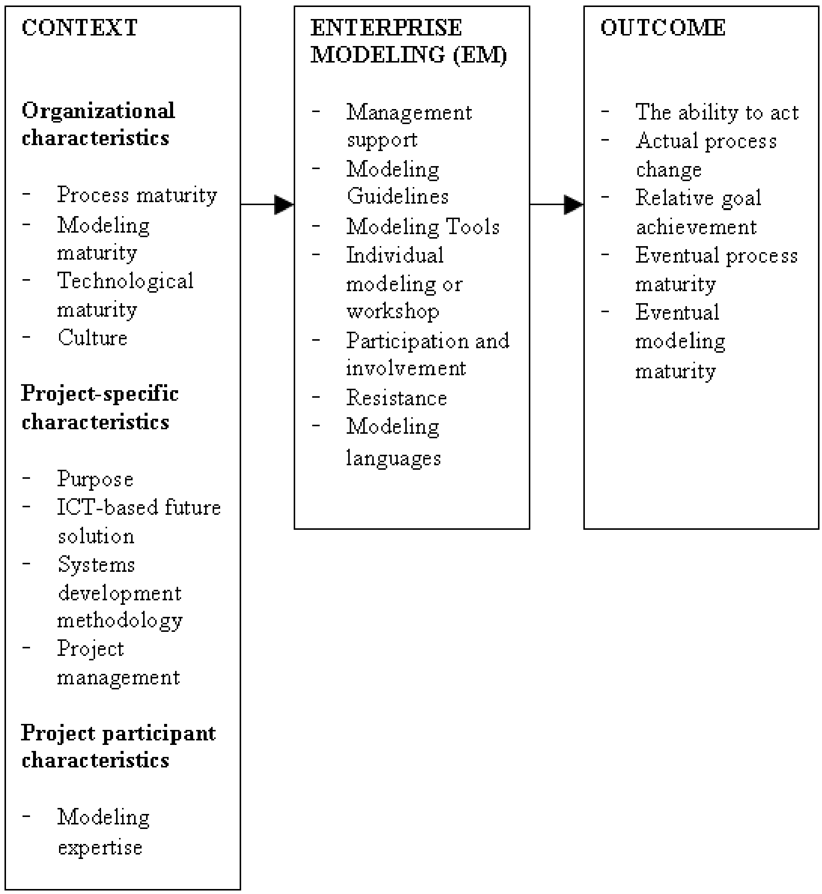

Fig. 2. The EMP model

Table 1. Enterprise modeling practice; Enterprise Modeling.

Category	Definition	Motivation
Management Support	The level of commitment by management in the organization to the modeling project, in terms of their own involvement and their allocation of valuable organizational resources. (Adapted from Sedera et al. [20])	Eikebrokk et al. [25]; Davenport[5], Sedera et al. [20]
Modeling Guidelines	A detailed set of instructions that describes and guides the process of modeling. (Based on Sedera et al. [20])	Sedera et al. [20]
Modeling Tools	Software that facilitates the design, maintenance and distribution of models. (Based on Sedera et al. [20])	Sedera et al. [20], Sommar [26], Eikebrokk et al. [25]
Individual modeling or workshop	To what extent EM is done as a team-work or on an individual basis. (Based on Davenport [5])	Davenport [5] and Eikebrokk [4]
Participation and involvement	The degree of input from stakeholders, for the design and approval of the models. (Based on Sedera et al. [20])	Eikebrokk et al. [25], Sedera et al. [20]
Resistance	A state of mind reflecting unwillingness or unreceptiveness. (Adapted from Hultman [29])	Eikebrokk et al. [25]
Modeling languages	The grammar or the “syntactic rules” of the selected modeling techniques.	Eikebrokk et al. [25]

EM will be studied along different dimensions, for example, what is modeled and why, when and how is modeling done during the ICT-enabled process change project.

Context. Context is defined as the setting of the project comprising organizational characteristics, project specific characteristics and project participant characteristics.

Organizational characteristics is a collective term of those organizational categories that might influence the modeling process. Based on the PMP project, relevant categories are process maturity and modeling maturity.

Project-specific characteristics is a collective term of those categories specific to the project that possibly influence the modeling process. In this category one find sub-categories like ICT-based future solution, Systems development methodology and Project Management, among others. The possible relevance of project-specific characteristics to EM might be indicated by the research of Sedera, Gable, Rosemann and Smyth [20], where Project Management was the most cited success factor in relation to process modeling across all three case studies.

Project participant characteristics are characteristics of those involved in the ICT-enabled process change project. It is singled out as a special category in the research model. In contrast, research on the PMP model does not have this perspective as an embedded unit of analysis. In conjunction with this category it can be mentioned that findings from the research of Sedera et al. [20] suggest that experiences with conceptual modeling is related to success in process modeling, indicating a possible relationship in the EMP model.

Each (sub-) category is further elaborated by sub-categories as shown in table 2, 3 and 4, where table 2 shows sub-categories of organizational characteristics in Context, table 3 shows sub-categories of project-specific characteristics in Context, and table 4 shows sub-categories of project participant characteristics in Context:

Table 2. Enterprise modeling practice; Context; Organizational characteristics

Category	Definition	Motivation
Process maturity	An organization's capability for process management and operation, including available competence and current practice. (Adapted from Eikebrokk et al. [4])	Eikebrokk et al. [4]
Modeling maturity	An organizations capability for EM, including available competence and current practice. (Adapted from Eikebrokk et al. [4])	Eikebrokk et al. [4]
Technological maturity	An organizations capability within the field of ICT; knowledge of existing solutions and knowledge of possible future or other enterprises solutions. (Based on Davenport [5])	Davenport [5]
Culture	The organizational readiness to accept and participate in a modeling initiative. (Based on Sedera et al. [20])	Sedera et al. [20]

Table 3. Enterprise modeling practice; Context; Project-specific characteristics

Category	Definition	Motivation
Purpose	The purpose of the ICT-enabled process change project	Pilot study (See section 4)
ICT-based future solution	Mean to enable process change. (Based on Davenport [5])	Davenport [5]
Systems development methodology	A standard process followed in an organization to conduct all the steps necessary to analyze, design, implement and maintain information systems [8].	Pilot study (See section 4)
Project management	A controlled process of initiating, planning, executing and closing down a project [8].	Sedera et al. [20]
Resources	Available time, money and people to initiate, plan, execute and close down a project [8].	Pilot study (See section 4)

Table 4. *Enterprise modeling practice; Context; Project participant characteristics*

Category	Definition	Motivation
Modeling expertise	The experiences of the project participants in terms of conceptual modeling in general. (Adapted from Sedera [20])	Sedera et al. [20], RAE [27]

Outcome is defined as the phenomena that follow and are caused by EM, including attainment of purpose and the effect of EM on the ICT-enabled process change project solution. This category relates to the outcomes expected as a result of EM; building upon the PMP project which suggests that the modeling process has an outcome not only relevant for the process per se, but influences the organization as a whole in form of eventual process maturity and modeling maturity. Outcome is further elaborated by sub-categories as shown in the following table:

Table 5. *Enterprise modeling practice; Outcome*

Category	Definition	Motivation
The ability to act	Knowledge; ones capacity to set something in motion. Nico Stehr [21]	Henderson [1, pp. xiii]
Actual process change[1]	The effect of EM on processes. (Adapted from Eikebrokk et al.[25])	Miller and Berger [14] and Vernadat [22]

[1] The PMP study operates with the category Outcome where attainment of purpose and effect of process modeling on processes are part of the Outcome definition. The EMP model instead operates with Outcome as a main category; where Eventual process maturity, Eventual modeling maturity, Actual process change and Relative goal achievement are sub-categories together with The ability to act; which the PMP-model does not include.

Relative goal achievement	The result of the project seen in accordance with overarching business objectives (cost reduction, time elimination and so forth). (Based on Davenport [5])	Eikebrokk et al. [25]
Eventual process maturity	Changes in an organization's capability for process management and operation, including available competence and current practice after the modeling process. (Based on the PMP study [4,9,25]	Eikebrokk et al. [25]
Eventual modeling maturity	Changes in an organization's capability for EM including available competence and current practice after the modeling process. (Adapted from Eikebrokk[4])	Eikebrokk et al. [25]

4 Pilot study: the corporate merger case

To gain additional insight from practice during the development of the EM practice model a preliminary investigation of a corporate merger process of Norwegian fish exporting firms was conducted [12].

Altogether 11 informants where interviewed covering an array of different perspectives towards the development of an Enterprise Resource Planning (ERP) system, system A, in the newly merged company. Through the study insight into a previous ERP development project, system B, in one of the merged companies was also gained.

A "snowballing" design was chosen, using sequentially dependent interviews based on interview guides with a set of open-ended questions or topic formulations.

The newly merged firm faced challenges of aligning its technical processes related to the flow of goods that transform raw-materials into marketable products and information to support this flow. System A that should solve many of these challenges had to be rapidly developed and implemented due to time constraints; the fish season was rapidly approaching giving a time frame of the development process of 6 weeks. This meant that those in charge of the system development in the merged company found no time for modeling processes. Instead decisions were made based on personal knowledge and perceptions on what were the central components in this kind of system and development of different screenshots, a kind of prototyping, of the future system. Participation and involvement from different kinds of personnel in the development process where decided to be restricted, thereby minimizing time used on discussions so that fast decisions and quick progress could be made. It was not possible to do things "by the textbook" one of the informants said.

Contrasting this way of developing an ICT system, the development of system B was emphasized. In this project different participants took an active role, something that was perceived as important in many ways. The solution that was made was better fitting the needs of the users. By taking an active role in the modeling, the future users of the system also gained a kind of ownership to the solution, thereby making them more satisfied. The fit between technical solution and the business processes was far better in project B, we were told.

In conjunction with the EMP model one can say that the merger case indicated that the categories project resources, project purpose and systems development methodology might influence on the modeling process, and that outcome of a "well-conducted" modeling process might improve user satisfaction through a better match between organizational needs and ICT solution but also through user participation.

These findings, which will be further examined, can be found under Context, table 3, in the EMP model.

5 Discussion

The EMP model builds extensively on the PMP model, concerning categories, definitions and motivations. At the same time there are some fundamental differences concerning the model build-up and scope of modeling practice research between the PMP and the EMP study.
The PMP study focuses on process modeling. The EMP study has a wider perspective; looking into the making of enterprise models in general in conjunction with process change enabled by ICT, being aware of the possibility that process models might be the main, or only, models that are made in the projects studied. This broader scope should allow an even more holistic approach and hence present a wider foundation for people venturing into such projects.

Whilst the EMP model to a large degree incorporates the categories of the PMP model, it additionally incorporates elements from literature and the pilot study that has not been a matter of concern in the PMP study. This mainly relates to project-specific characteristics as mentioned in the merger case, but other sub-categories can also be found, for example “Technological maturity” in organizational characteristics. These additions to the PMP model also contributes to widen the scope by also taking other factors from the existing literature into account.

The PMP study gains information from people that typically act as project facilitators, in projects mainly linked to quality management in their organizations.

The EMP study will gain information from different stakeholders involved in the projects, in projects for example related to supply chain management; where flow of goods and flow of information are central along with creation or improvement of information connectivity of the actors in the supply network. This multi-stakeholder perspective will most likely contribute towards a more objective representation of opinions and perceptions among project participants.

Whilst the PMP project selected process change projects within an array of different sectors from all over Norway, the EMP study will mainly look into the furniture, the marine, and the maritime sector. These are clusters that to a large degree are situated on the west coast of Norway, far from their markets, and that compete on a global basis. Focusing on these three clusters might very well turn out to be valuable to the EM practice study. For example, there might be sector differences that turn out to influence degree of modeling and there might also turn up some cultural factors that are interesting.

Whilst the PMP study focuses on projects where it is known or highly expected to have been conducted modeling, the EMP study will open up for cases where modeling is omitted. As seen from the corporate merger case these instances might also reveal interesting relationships.

The aim of the EMP study is to function as a supplement to the PMP research; both studies aiming at contributing towards a theory of model-based process change.

6 Concluding remarks and further work

The EMP research model constitutes the foundations for a study of EM practice in ICT-enabled process change projects. Having assessed existing knowledge, I will now turn to current practice in companies on the west coast of Norway.

In regard to the research model examples of relevant questions are:

- For what purposes are modeling used in process change projects?
- How does the purpose of the modeling affect how the modeling is carried out?
- How is the modeling process affected by the level of initial process-, and modeling maturity?

- What are the effects on the outcome by the modeling process itself and by the level of sophistication of the modeling?

The scope of further work on EM in ICT-enabled process change allows the project to focus on potentially complex change processes, with a high degree of organizational impact, cross functional and cross organizational implications and involvement.

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II

Benefits of Different Types of Enterprise Modeling Initiatives in ICT-Enabled Process Change

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Abstract

The paper reports a study that investigates the use of enterprise modeling empirically in eight combined process change and information technology initiatives. The paper targets a need in academia and industry for knowing more about enterprise modeling in practice. We identify five different types of modeling initiatives by analyzing how each case combines the use of ICT, the main focus of process change and the objectives of modeling. We then identify and compare the reported benefits of enterprise modeling in each type of initiative. We conclude that, in order to be able to give a qualified answer to executive management on the potential benefits of an enterprise modeling initiative, it is beneficial to identify the type of initiative in question.

Keywords: enterprise modeling, process modeling, business process change (BPC), business process improvement (BPI), process-modeling success

Introduction

Enterprise modeling (EM) is often used as a catch-all title (Fraser, 1994) covering the set of activities, methods and tools used to develop models of various aspects of an enterprise (AMICE, 1993; CEN, 1994; Petrie, 1992). A model of a business process is an example of such an enterprise model (Andersen, 2000). The aim of EM is to externalize knowledge that adds value to the enterprise or needs to be shared (Fraser, 1994). According to White and Miers (2008) people generally use models to underpin their conversations, communication and understanding, so that the models act as a backdrop for all improvement or business change programs. The assumption has so far been that humans are the primary consumers of models, but today models also can play the role as primary inputs to a business support environment.

This paper reports a study where the use of EM has been empirically investigated in eight real-life Norwegian cases. Each them combined process change and technology initiatives so that information and communication technology (ICT) functioned as an enabler of process change. The motivation is that research on EM in practice has been more or less neglected by the research community (Persson, 2001). We include both cases where models were made and used by human beings as part of process change processes and an initiative where models were made as input to a business support environment in the form of a quality system, thereby enabling process change in the long run.

We first present a literature review, followed by our overall research design. The following section presents the three types of process change focus and the four different types of ICT-initiatives we found in our cases. We then describe the five different types of modeling initiatives we identified, along with the benefits of modeling reported for each of them. Finally we discuss the contributions and limitations of our study and make suggestions for further research.

Background

EM as a term to describe the activity of modeling any pertinent aspect of an organization (Fraser, 1994) is nothing new. Over the last decade different enterprise architectures have been developed, like the Zachman Framework for Enterprise Architecture (Schekkerman, 2004; Urbaczewski & Mrdalj, 2006), DoDAF (Urbaczewski & Mrdalj, 2006), PERA (Schekkerman, 2004) and CIMOSA (Kosanke, 1995), to mention just a few. In addition, several commercial computer tools have come into the marketplace to assist with architecture visualisation and modeling.

Persson (2001) states that extensive research efforts have been invested into the development of EM languages, but that considerably less effort has been devoted to gain knowledge about EM practice. Motivated by this knowledge gap she investigated situational factors and their influence on adopting a participative approach in EM practice. She came up with recommendations for use of EM particularly in the requirements engineering stages of the development process, and a grounded framework of situational factors that influence the applicability and application of participative EM, together with a theory with regard to how the factors affect each other.

Persson and Stirna (2002) report from two separate EM research projects where one targeted ways of working and the other tool support. They carried out case studies, company observations and a total of 22 interviews. Persson and Stirna (2002) believed that to be able to formulate practical guidelines for EM tool acquisition, the guidelines had to be grounded in substantial practical experience, calling for the need to mainly target expert EM method and tool users in the interviews. A conclusion from their studies is that participative EM should only be applied in consensus oriented organizational cultures, and if properly applied it is a very strong way of committing stakeholders to business decisions.

Within a sub-field of EM, process modeling, Recker, Indulska, Rosemann and Green (2010) did an exploratory empirical investigation on the ontological deficiencies of process modeling with the industry standard Business Process Modeling Notation (BPMN). In the study they highlight the need for consideration of representational issues and contextual factors in decisions relating to BPMN adoption in organizations.

Glassey (2008) has done a case study where three process modeling techniques, Adonis, OSSAD and UML, are compared in order to find common concepts and to identify significant differences. He concludes that at the operational level the three techniques are equivalent and can be used indifferently. At the structural level the choice of technique are dependent of the domain to be modeled.

Sedera, Gable, Rosemann and Smyth (2004) conclude that, whereas there has been much research on process modeling techniques and corresponding tools, there has been little empirical research into important factors of effective process modeling and post-hoc evaluation of process modeling success. As part of their research they have developed a success model for business process modeling by conducting a multiple case study. Bandara and Rosemann (2005) report a detailed case study conducted at a leading Australian organization contributing to the build-up of their success model for process modeling.

In the related knowledge modelling field, Sandkuhl (2010) has investigated use of modelling to capture organizational knowledge for supporting product development with task patterns, and evaluation of task pattern use with a focus on economic effects achieved. His results are based on work in the EU-FP6 project MAPPER (Model-adapted Process and Product Engineering) where analysis of requirements for collaborative engineering support, development of a collaboration infrastructure, and application of the infrastructure in daily work was performed in an industrial case taken from automotive industries. He concludes that the industrial application of task patterns proved both feasible and deployable and resulted in a number of positive evaluation results; shortening of lead times, increased quality of product documentation, and improved quality of best practices when using knowledge models instead of conventional documentation.

Kock, Verville, Danesh-Pajou and DeLuca (2009) emphasize that business process redesign has been intensely studied since the 1990s but that little attention has been paid to the relationship between business process choices and redesign success. Through a multi-method study of eighteen business process redesign projects in eighteen organizations, they found that a focus on communications flows in business processes is an important ingredient in successful business process redesign projects.

Mendling (2008) investigates and discusses metrics for business process models and argues that one needs suitable measurements. He emphasizes that in an emerging discipline like complexity of business process models, it might not be clear what to measure in the first place, but that proposing and discussing measures opens a debate that ultimately leads to greater understanding.

Eikebrokk, Iden, Olsen and Opdahl (2006) have conducted a study of Norwegian model-supported process-change practice guided by an a process-modeling-practice (PMP) model (Iden, Olsen, Eikebrokk, Opdahl, 2006; Eikebrokk, Iden, Olsen & Opdahl, 2008). Their investigations suggest that a combination of technological, social and organizational factors explain the outcome of model-based process change projects.

Indulska, Green, Recker and Rosemann (2009) report a Delphi study leading to the identification and ranking of 19 unique benefits associated with process modeling. They explored what are the main perceived benefits of modeling by asking various academics and practitioners in the business process modeling domain, vendors of business process modeling software tools, as well as consultants. Practitioners and vendors agreed that process improvement is the top process modeling benefit. Academics, on the other hand, perceived model-driven process execution as the number one benefit derived from process modeling activities. They also found that the academics ranked process simulation and process verification among the top-five process modeling benefits. Improved understanding was highly ranked across all stakeholder groups.

Our literature review indicates that, despite much research on enterprise modeling and its sub-field process modeling, there is still much unknown, especially about modeling practice. The choice of dedicating a paper to the benefits of EM is linked to our initial research objective to identify consequences of EM in practice. Indulska et al. (2009) states that little is known of the actual benefits of process modeling in academia and practice. To our knowledge, not much is known on the benefits of EM in ICT-enabled process change either. Our choice of focus – on EM in process change initiatives where the implementation of new IT solutions is the conditioner – is partly inspired by earlier work on the use and usefulness of EM in information systems development (Persson 2001) and partly by Davenport's (1993) work on information technology as an enabler of process change, which provides numerous examples of firms that have succeeded or failed in combining process change and technology initiatives. A possible contribution of our work can be the avoidance of similar situations as described by Indulska et al (2009), where lack of insight makes modeling a time-consuming and costly exercise and makes it difficult to convince executive management of its benefits.

Research method

Choice of design. Our study is part of a larger research program with the overall research question: "How is EM used, and how can it be used to support ICT-enabled process change in Norwegian companies?" We have chosen an exploratory/explanatory multiple case study because we investigate a contemporary phenomenon in depth and within its real-life context, and because the boundary between the phenomenon we study and its context is not clear (Yin, 1984; Yin, 2009). It is also an appropriate method because we study "why" and "how" questions that deal with operational links to be traced over time rather than with frequency or incidence (Benbasat, Goldstein & Mead, 1987). Case study research is the most common method used in information systems research (Alavi & Calson, 1992; Orlikowski & Baroudi, 1991; Myers & Avison, 2002). As shown in the previous section, it has already been used within the EM field and the related field of process modeling, for example by Persson and Stirna (2002) and by Bandara and Rosemann

(2005).

Research model. An explicit research goal is useful because it makes the objective of a study clear (Wolcott, 1982; Miles & Huberman, 1994). We had already chosen Eikebrokk et al's (2006) PMP model as our starting point for a research model for EM practice, the Enterprise Modeling Practice (EMP) model, presented in (Karlsen, 2008), based on a pilot study and literature review. We set as our research goal to validate and elaborate the EMP model further.

The EMP model has three main categories: Enterprise Modelling (EM), Context and Outcome. Context was defined as the setting of the project comprising organizational characteristics, project-participant characteristics and project-specific characteristics. Outcome was defined as the phenomena that follow or are caused by EM and consisted of the categories (1) “The ability to act”, defined as ones capacity to set something in motion, (2) “Actual process change”, defined as the effect of EM on processes, (3) “Relative goal achievement”, defined as the result of the project seen in accordance with overarching business objectives, (4) “Eventual process maturity”, defined as changes in an organizations capability for process management and operation, and (5) “Eventual modeling maturity”, defined as changes in an organizations capability for EM. Through these categories, the EMP model expressed our initial assumption that modeling would provide various benefits, concrete in the form of increased ability to make good decisions (ability to act), improved modeling and process maturity, and relative in the form of various goal achievements seen in accordance with overarching business objectives.

The case study. Having designed a research model to guide the collection of data and their subsequent analysis, we developed a semi-structured interview guide with questions derived from the categories in the EMP model (see Appendix A for the interview guide).

We then selected eight combined process change and ICT initiatives to include in our study, based on the following two criteria: (1) The organizations behind the initiatives should be available and willing, in the sense of being available and willing to provide in-depth insight into EM practice via interviews and supplemental information. (2) The respondents in the organizations defined the projects as ICT-enabled process change.

We had no initial knowledge of the enterprises and their modeling practice at the onset of the study. With such limitations about what to find, we chose to use the term EM in a broad sense, to capture how the companies in fact used modeling; possibly by using both formalized and non-formalized languages, simple tools, etc.

We used the internet and telephone to search for cases. We contacted consultants and IT-vendors and asked if they were involved in change processes that could be of relevance, or if they could provide tips on organizations they had heard of. This process led to the study of eight cases, defined as a constellation of (1) a main organization or (2) a consulting company and/or an IT-vendor, in the investigation. The main organizations of these cases were in the construction industry (case C1), the marine sector (cases C2 and C4), the maritime sector (cases C3 and C8), the offshore sector (case C5) a wholesaler within the food sector (case C6) and the banking sector (case C7) (see Appendix B for additional case information).

A total of thirty persons were interviewed as part of our study: two expert informants, six informants at the pilot stage to underpin the research model, and twenty-two informants from our eight cases. In addition a rich variety of material was collected in the form of model prints, reports and historical material. Organizational information was additionally downloaded from the internet. We also visited the various companies and got demonstrations of the software solutions involved.

Analysis. All interviews have been transcribed and transferred into Nvivo 9, a computer-assisted qualitative data analysis software, generating more than 500 pages of transcribed text together with links to all other types of material for analysis. To guide the analysis we used Qualitative analysis: An Expanded Sourcebook by Miles and Huberman (1994). This book gives a thorough explanation of coding as analysis, where coding is described as tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study.

The research model that initially guided data collection was also used in the initial computer-assisted analysis by providing initial constructs on characteristics of context possibly influencing on the modeling process, constructs on characteristics of the modeling process and the outcome of modeling. The coding process of the interview transcripts started by building a node tree, containing the initial constructs of the EMP model. Then a first reading through of all interviews was conducted to identify text related to these constructs. All constructs, represented by a node which was not part of the initial tree structure were Nvivo coded and later specified under new appropriate nodes. Figure 1 is an adapted print screen from Nvivo 9 showing the node structure of the EMP model, with a node associated with benefits of modeling expanded.

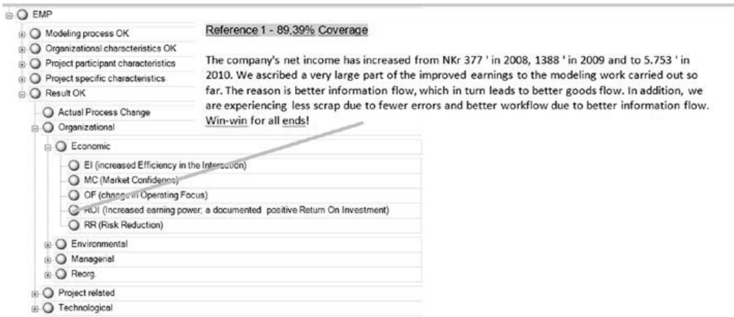

Figure 1: Coding in Nvivo

By clicking on a node, sources coded at that particular node are opened. Each node can be associated with references to multiple sources. Nvivo provides database facilities useful on large data samples and keeps track of information that is related to the same subject areas.

To increase the quality of the coding process, the material was re-read to check that nothing important had been missed in the reading process. Missed text sequences were linked to existing or new nodes. Thereafter followed a process where all material linked to each node was controlled, to ensure consistency between selected text and the node assigned. Thereafter, there was a process where material connected to a particular node was questioned to see if it should be broken into sub-nodes. If a sub-classification seemed appropriate, the change was made. The coding process resulted in an array of different constructs representing findings on enterprise modeling practice.

Identifying the process change and ICT initiatives

We will now present the three types of process change main focus and four different types of ICT-initiatives that we found in our cases.

The process change main focus. We first investigate the process change main focus in our cases. Analysis indicates that seven cases focus on changing information flow as part of process improvement (cases C1 to C5 and cases C7 and C8). Five cases focus on altering work practice (cases C1 to C3 and cases C6 and C7). Of these, two cases (cases C6 and C7) focus on improving work practice by technology, whereas three cases alter work practice by physical intervention (cases C1 to C3). Four cases have a double focus on altering both work practice and information flow (cases C1 to C3 and case C7).

Cases C4, C5 and C8 focus on information flow. In case C4, they decided to let the workflow of the laboratory be the starting point and adapt the software as closely as possible to work practice, "*because it is a proven and validated process*" [2. Interview, C4]. In case C5, a project participant describes a modeling process primarily focusing on information flow: "*It went on: what do you need of information in advance, what do you need of information afterwards to bill and report, and all this. There was little focus on the value-adding activity of NN*" [1. Interview, C5]. The physical processes enacted by field personnel were not central in the modeling process. In case C8, the project focused solely on information flow: "*It is crucial, both in relation to the management of logistics and the management of drawings. Concerning control of the logistics we still have a great potential. When it comes to the economy part, because we are relatively good at project execution and control of costs, we have a potential in creating a calculation part of this tool here, and making* *reporting more efficient."* [2. Interview, C8].

Cases C6 and C7 focus primarily on altering work practice by technology. *"Simply put, pickers work with a number of fixed commands given from the system's central unit. When the picker logs in with a unique password, the central unit maps where the individual is, which truck is used and the movement pattern of all trucks. In this way, as an example, additional ordering of a truck is handled – one that is closest to the freight location, not necessarily the one that placed the order in the first place. One of the effects is a strong reduction of the lead time".* [Article, C6]. "*Concerning the choice of tools it is emphasized that the quality system is simple and straightforward, and that it will affect the 'way we do things'*" [Decision-making document, C7]. In addition, case C7 pays some attention to information change because it is stated that various disadvantages will be reduced in a group with a satisfactory quality tool/system: *"Sub-optimization, disclaim, poor collaboration between disciplines and departments, lack of holistic views and understanding, low customer awareness.*" [Acquisition document, C7]. .

Cases C1, C2 and C3 deliberately focus on improving both work practices and information flow. In case C1 it is emphasized that "*It is to improve both workflow and throughput, but the Achilles heel is the flow of information"* [1. Interview, C1], whereas C2 says "*the purpose was to design an organization .... The other side of it was that it would form the basis to replace the control systems. So part of what came out of it was a specification for a new IT system…"* [2. Interview, C2]. This double-focus is also seen in case C3 where" *We have the idea behind, concerning overall corporate governance, that we should understand the processes...to know where the company want to go and be and all that…And the flow of information, not least."* [1. Interview, C3]. Our analysis also shows that whereas case C6 and case C7 attempt to improve work practice by technology, cases C1, C2 and C3 instead attempt to improve work practice by physical intervention to reach a growth strategy or a LEAN strategy. Table 1 summarizes the process change main focus in our cases.

Table 1

Process change main focus in cases

Process change main focus		
Improving information flow	Improving work practice by physical intervention	Improving work practice by technology
C1, C2,C3,C4,C5,C7, C8	C1, C2,C3	C6, C7

The ICT-initiatives. In the same manner, combined with on-site demonstrations of the ICT-systems involved, analysis leads to the identification of four different types of ICT-initiatives associated with our cases, as shown in Table 2.

Table 2

Type of ICT-initiative in cases

Type of ICT-initiative	Cases
Introduction of a quality system	C7
Introduction of a wearable voice-directed warehouse application system	C6
Development and introduction of an industry-specific ERP solution	C8
Introduction of a standardized ERP solution	C1, C2,C3, C4, C5

Identifying different types of modeling objectives

Next, we investigate the modeling objectives associated with the various change efforts. The coding process leads to the identification of six types of modeling objectives (M1 to M6), which we identify by quotes from the informants.

M1: Modeling to reveal the AS-IS situation. This modeling objective was expressed by C4 saying that they "*decided to let the laboratory be governing, and adapted the software as close as possible to the laboratory, because it is a proven and validated process*" [C4, 2. Interview]. C5 emphasized that processes were modeled "*to gain understanding, at an overarching level, of system needs to be able to create a requirements specification"* [C5, 1. Interview].

M2: Modeling as input to a report. This modeling initiative was subdivided into (1) M2.1: Modeling as input to a requirements specification for the selection of a new ICT system and (2) Modeling as input to a preliminary report indicating the necessary alignment between a chosen ICT solution and the business processes of an organization, based on C5 stating that they modeled "…*to be able to create a requirements specification"* [C5, 1. Interview] and C4 stating that "*we made a requirements specification there as well, so we had to go through feature by feature and say that there must be customizations based on describing the value chain from order to product too*" [C4, 3. Interview]. In C8 it was stated that they made models as input to a preliminary report "*indicating the necessary alignment between the chosen ICT solution and the business processes of the organization*" [C8, 1. Interview].

M3: Modeling to reveal the build-up of applications. This modeling objective can be seen in C8 where a project participant explains that he "*mapped what was equal in the solutions and what was different in order to ensure getting the functionality we depend daily"* [C8, 2. Interview].

M4: Modeling to fill a quality system with process descriptions based on a specific guideline was identified as a modeling objective in C7. In this case they had "*a framework for modelers and facilitators, which says: This way we build the system. And ...Here are the guides for everyone involved, both on how to model objects, how to model the processes, and how to model different aspects of the quality system. And so you have the manuals for these players"* [1. Interview, C7].

M5: Modeling to reveal differences between organization and system based on vendor supplied models was an objective identified in C6, where a consultant expressed that "*We were so lucky that we had process descriptions from* *the system vendor. It is that simple. And it's an American company that has created it in the first place. They supply a number of models, and descriptions of ...or ready-made models that show how the various processes are made, how to go through the picking process. And then we went through them, with resource persons, step by step. Does this work? Is this the way you work? Is it not? We then had to look at the process that was put up by the system manufacturer. Then we had to look at: can we use them or do we need to make customizations?"* [C6, 2. Interview].

M6: Modelling to reach a strategy. This modeling objective was subdivided into (1) M6.1: Modeling to reach a LEAN strategy and (2) M6.2: Modeling to reach a growth strategy. In C1 they explained that "*The main principle of Lean thinking is to avoid waste, ...so we had a meeting with those who are out on the workplace and last weekend we had a meeting with the building managers and salespeople who work in the office, and it is the closest to such 'go and see'. We are talking with them to identify how they do it today, and at the same time we discuss whether it makes sense to make adjustments."* [C1, 2. Interview] In C3 we identify the cost reduction aspect when C3 says that there are *"two navigation stars in this. One is cost reduction. We have to find more economical ways to handle this. The second is that the company's reputation being damaged"* [C3, Mail from consultant]. In case C2 they focus on growth in the modeling process and say that "*we knew the status at the time we started, and we know as well what is expected of us if we're going to reach a growth strategy. So it was a very important part of it, to move from AS-IS to the point we want to be in the form of processes."* [C2, 1. Interview]

Table 3 summarizes the case distribution over types of modeling objectives.

Table 3

Modeling objectives in cases

	Types of modeling objectives							
	M1	M2.1	M2.2	M3	M4	M5	M6.1	M6.2
C1							+	
C2								+
C3				+			+	
C4	+	+						
C5	+	+						
C6						+		
C7					+			
C8			+					

The modeling initiatives and benefits of modeling

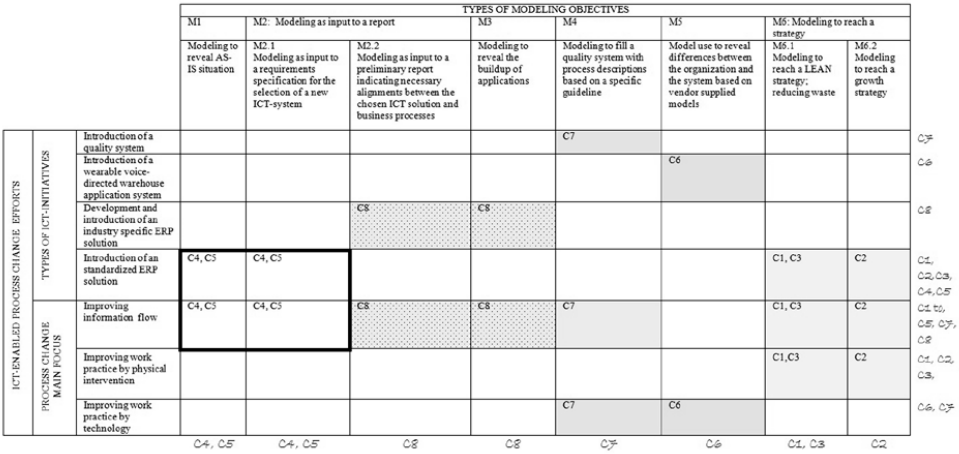

Figure 2: Identifying different types of modeling initiatives

Figure 2 shows how types of modeling objectives, types of ICT-initiatives and process change main focus combine in particular ways in our selection of cases. In the figure we have marked areas where different cases cluster together and share a commonality concerning type of ICT initiative, project change main focus and modeling objectives. This leads to the identification of five different types of modeling initiatives, which we will call Strategy, Industry, Dataflow, Work and Support in the following.

Cluster C1 - C3: From figure 2 we reach the conclusion that cases C1 to C3 combine the following modeling objectives and ICT-enabled process change efforts: (1) IT initiative: Introduction of a standardized ERP solution, (2) Process change main focus: (a) Improving work practice via physical intervention and (b) Improving information flows, and (3) Modeling objectives: To reach a given change strategy; LEAN or growth. We therefore define the Strategy initiative as follows:

"Strategy": Modeling to reach a change strategy in a long term business change initiative with a mixed focus on improving work practice via physical intervention and improving information flows via IT.

Example case: In the following, one case associated with the strategy initiative is further investigated. The case relates to the construction industry and is chosen as being the case including the richest and most in-depth material supplementing the interview statements concerning EM usage and outcomes. Both economic figures and meeting protocols are made available for research, following the lifecycle of the process change process. The project was initiated in an attempt to reverse a serious negative financial situation.

Benefits in the example: An array of modeling benefits is identified in the construction industry case relating to the making and use of model artifacts to support the change process as can be seen in Table 4, column "Strategy". According to one of those with a central role in the organizational change process the company's profit after tax increased more than tenfold from 2008 to 2010 (NKr 377' in 2008, 1388' in 2009, and 5753' in 2010).

Table 4

Benefits of EM

	Strategy	Industry	Dataflow	Work	Support
Actual Process Change (APC)	+		+	+	+
Organizational					
Economic					
Increased efficiency in the interaction	+				
Market confidence	+				
Change in operating focus	+				
Increased control into orders and finances; a positive ROI	+				
Environmental					
A modified atmosphere in the organization	+				
Culture change	+				
Reduced change resistance	+				
Optimism and motivation/Improved working environment	+				
Managerial					
Employee training	+				
Insight into corporate challenges	+	+			
Reorganizational					
Reorganization and overview of who should do what	+			+	
Project-related					
An awareness-raising process in itself	+			+	+
Change in modelling competence	+				
Changed mindset	+				+
A common picture of the business	+			+	
A communication tool	+				
Further involvement in the organization			+		
Understanding the organization			+		
Making the intangible into something tangible					+
A more positive attitude towards model making	+				+
On a personal level	+		+		+
Being prepared to meet with the supplier		+			
Increased ability to process thinking	+				+
A thinking tool		+			
Increased ability to act	+		+		+
Technological					
An appropriate solution		+*	+	+	
Image of areas the IT-solution must meet		+	+		
The ability to provide precise requirements			+		
Disclosure of existing procedures		+			
Input to the systems-related	+	+	+	+	
Disclosure of adjustments between processes and system		+		+	
Potential input to quality system		+	+		
Qualified choice of IT-provider			+		
Input to the requirement specification or preliminary report		+	+		
Understanding of systems requirements		+			

They relate a large part of the improved earnings to the modeling process aimed at improving their business process. "*The reason is better information flow, which in* *turn leads to better goods flow. In addition we are experiencing less scrap due to fewer errors and better workflow due to better information flow: A win-win for all ends!"* [1. Interview]. That they use a Lean strategy and aim at an operating profit of 10% of sales is emphasized. It is also emphasized that they feel they now sell houses more easily as a result of an improved reputation in the market. They have become reliable and deliver error-free on time. Which can be seen from Table 4, column "Strategy", the benefits are linked both to economic, environmental, managerial, re-organizational, technological and project-related aspects.

Cluster C4-C5: The next "box" in Figure 2 which we examine relates to C4 and C5, where we find the following modeling objectives and ICT-enabled process change efforts: (1) IT initiative: Introduction of a standardized ERP solution, (2) Process change main focus: Improving information flow, (3) Modeling objectives: (a) Modeling to reveal AS-IS situation, (b) Modeling as input to a requirements specification. We define this type of modeling initiative as:

"Dataflow": Modeling to reveal AS-IS as input to a requirements specification in a change effort to improve information flows.

Example case: In the following one of the cases of this type of modeling initiative is further investigated. The case relates to a subcontractor in the offshore industry and is chosen based on an evaluation of being the case which focus most on the goal of revealing the requirements of a new solution. The project was initiated after a common understanding of having a present ICT system not fulfilling organizational needs. An external consultant is commissioned to clarify the requirements that must be set for the new ICT-solution.

Benefits in the example: The benefits of this modeling initiative can be seen in Table 4, column "Dataflow", being divided between project-related benefits and technological benefits. Modeling is seen as a tool to gain insight into the organization and thereby contributing to increased ability to make good decisions.

Through the mapping of business processes the external consultant accrues unique expertise and insight into the business. This is one of the factors that contribute to a continuation of his involvement in the company. When it comes to gains of a more technological nature, it appears that the modeling initiative helps clarify an appropriate solution by providing a compressed picture of important areas the solution must meet. The requirements specification forms the basis for a round of assessments of various solutions offered by ICT vendors. By influencing the ability to understand and make good decisions the modeling process is seen as influencing the ability to make a qualified choice of the right ICT-provider.

Cluster C6: Concerning C6 we identify the following constellation of modeling objectives and ICT-enabled process change effort in Figure 2: (1) IT initiative: Introduction of a wearable voice-directed warehouse application system, (2) Process change main focus: Improving work practice by technology and (3) Modeling objective: Model use to reveal differences between organization and system, based on vendor supplied models.

This leads to the following definition of the type of modeling initiative related to C6:

"Work": Utilizing vendor supplied models to reveal differences between a wearable voice-directed warehouse application system and the organization in a change effort to improving work practice by technology.

Example case: The case relating to this type of modeling initiatives is provided by a large Norwegian wholesaler. An ICT-solution aimed at improving inventory management was ordered from a foreign company. The system was delivered accompanied by various flow charts. By mapping the vendor supplied flow charts with practice in the warehouse, one became able to identify to what extent one had to do adjustments in one's own work processes or whether it was necessary to do some IT-solution adjustments. Modeling in this case is thus the use of vendor-supplied models to clarify the necessary organizational and ICT-system tweaks.

Benefits in the example: The benefits of this modeling initiative can be seen in Table 4, "Work". In this case applying the vendor supplied flow diagrams and matching them with the actual processes in the warehouse is seen as an awareness-raising process by itself. By using the models and walking around in the warehouse the project participants acquired a common picture of business and were able to determine the necessary adjustments in organization and system.

Cluster C8: Concerning C8 we identify the following modeling objectives and ICT-enabled process change efforts in Figure 2: (1) IT initiative: Development and implementation of an industry-specific solution, (2) Process change focus: Improving information flow, (3) Modeling objective: Modeling as input to a preliminary report indicating the necessary alignment between the chosen ICT-solution and business processes. We define this type of modeling initiative as:

"Industry": Modeling to reveal the build-up of market leaders' IT solutions to develop a joint industry-specific IT solution and modeling as input to a preliminary report to communicate the necessary alignment between this joint solution and specific actor needs.

Example case: One case relates to using and developing of modeling artifacts as part of developing and implementing an industry-specific Enterprise Resource Planning (ERP) solution in the maritime sector. The case relates to a time horizon of more than 20 years from the early days when leading companies within the industry joined together to develop a common ICT solution and to this day where companies adopt the solution and in a way "inherit" the enterprise processes of the solution architects. This is the reason why this modeling effort can be subdivided into (1) a modeling effort for developing the industry-specific enterprise resource planning solution and (2) a modeling effort for implementing the industry-specific enterprise resource planning solution in an organization, where the second modeling effort must be understood by the first, an aspect elaborated in the discussion.

Benefits in the example: Benefits associated with this initiative are seen in Table 4 in the column "Industry". As mentioned, this modeling effort is subdivided into (1) a modeling effort for developing the industry-specific enterprise resource planning solution and (2) a modeling effort for implementing the industry-specific enterprise resource planning solution in an organization. The benefit associated with the first modeling effort is the accomplishment of an appropriate industry-specific solution (marked with +* in column "ERP" by sewing together the existing ICT-solutions of two market leading companies in the industry. The industry-specific solution is initially developed by matching the model descriptions of the two company solutions and 'picking the best' for a joint system. The remaining benefits relate to the later adoption process of the industry-specific solution in companies within the same industry. This adoption process follows a common development pattern whereby an initial preliminary report is written summarizing the needed alignment between business processes and the industry-specific solution. Modeling is done as part of identifying needed adjustments.

Cluster C7: Concerning C7 we identify the following constellation of modeling objectives and ICT-enabled process change efforts: (1) IT initiative: Introduction of a quality system, (2) Process change main objectives: Improving work practice by technology and improving information flow, (3) Modeling objectives: Modeling to fill the computerized system with process descriptions based on a specific guideline. Based on this we define this type of modeling initiative as.

"Support": Modeling to fill a quality system, with process descriptions based on a specific guideline, focusing on developing a business support environment, where it is expected that in the long-run shared common models of work practice will improve business processes.

Example case: One case relates to this type of modeling initiative in one of the largest banks in Norway. The background for the project is a realization, obtained through a strategy process, that process improvement, management and simplification are important development points for all the bank's business and support areas. At the start of the project it is recognized that the current structures and systems are complex, and that work processes should and could be improved. The bank expresses the goal of simple, standardized processes supported by best practice in the application of modern technology. Modeling is done to fill the quality system with common work practices in the bank.

Benefits in the example: A range of outcomes is associated with collecting and sharing improved enterprise models via the quality system as can be seen in Table 4, column "Support" and Table 5. Some of the outcomes (Table 4) are perceived during the phase of filling the quality system with content, whilst other outcomes (Table 5) result from sharing of model artifacts through the system.

Table 5

Benefits of model sharing via a business support environment

Quality system
A common basis for discussion
Common understanding of business processes
Simplification of the documentation process in accordance to external demands
Improved decision making
A holistic view of the enterprise
Increased availability
Improved efficiency in internal processes
Long-term gains
Reorganization
Safer decisions
Simplified mobility of employees
Improved service quality
A strategic tool
Simplified working days
Simplified training of new employees
A tool for managing IT-entries
Uniform work methods
Visible and accessible requirements from a process perspective

First and foremost the quality system increases the availability of information. The availability aspect is said to improve the decision-making process, making decisions safer, improving service quality, and insuring uniform work methods within the bank. It is also emphasized that having enterprise models available via a computerized system simplifies the documentation process in relation to external demands. In general it simplifies working days, improves efficiency in internal processes and training and mobility of employees. The quality system is described as a strategic tool and as a tool for managing IT-entries, constituting visible and accessible requirements from a process perspective. In general having a shared reservoir of enterprise models via a quality system provides a holistic view of the bank and a common basis for discussion based on a shared understanding of business processes. The modeling process whereby model artifacts are developed is described as a learning process resulting in a greater awareness concerning how work is done. It is stated that a series of eye opening experiences relates to the modeling process. Questions are raised as to why things are done in a certain way. Process maturity, the ability to process thinking, is dramatically improved during the period of process modeling to fill the quality system with content. Concerning this last experience, the following statement indicates what is in the wake of introducing the quality system in the bank: "*The consequence of introducing a process-oriented quality system in a hierarchical organization is that you end up conducting organizational development, and this is something the organization possibly has not been aware of having acquired*" [4. Interview, C7].

Discussion

Our analysis of the eight cases has led to the identification of five different types of modeling initiatives. Although all our cases combine process change and technology initiatives, they are different when it comes to both modeling objectives, type of ICT-initiatives and process change main focus. Our analysis has shown that the benefits of modeling depend on type of modeling initiative in question. Strategy initiatives are mainly focusing on modeling to accomplish an overarching change strategy, whilst Industry, Dataflow and Work initiatives have stronger focus on the technological part of ICT-enabled process change. Industry initiatives have been subdivided into one part of the initiative focusing on the actual making of the industry-specific ERP solution and another part where the specific ERP solution is adopted in an organization. The benefit of model-making in the first part of the initiative is described as an aid in settling for an appropriate solution. The other benefits relate to the second part and the making of models as input to a preliminary report. Dataflow initiatives bear resemblance with the modeling effort associated with the second type Industry initiatives, but, where the Dataflow initiatives focus on specifying what requirements should be made concerning a future IT-solution, in the Industry initiatives the solutions are given leading to a matter of focusing on identifying necessary alignments between processes and the industry-specific solution. Support initiatives are the only that focus on the creation of business support environments, a type of quality system, with the benefits associated with modeling primarily linked to model sharing and availability. These benefits can be seen as long term gains whereby the common model reservoir in the long run helps the organization in making safer decisions etc. based on a common understanding of business processes. Comparing the Strategy to the Support initiatives, we argue that there are some similarities between the two modeling initiatives if one eliminates the time factor associated with having to fill a quality system with models before one in the next round is able to reap the benefits of modeling. The change focus associated with Strategy initiatives is focusing on organizational change at large, involving both the redesign of work processes and improving the information base to support work accomplishments. In this sense this change initiative has a broader focus than the change initiative associated with Work, which specifically focuses on the introduction of a new technological solution. In the Strategy initiative case, both economical, organizational, project-related and technological benefits are identified.

The focus area of the change initiative seems decisive for the modeling outcomes to be experienced and expected. To check this assumption we investigated the distribution of all cases within each type of modeling initiative with the overarching type of modeling benefits as shown in Table 6.

Table 6

Benefits of modeling associated with cases in different types of modeling initiatives

	Strategy			Dataflow		Industry	Work	Support
	C1	C2	C3	C4	C5	C8	C6	C7
Actual process change	+	+	+	+	+		+	+
Organizational	+	+	+			+	+	
Project related	+	+	+	+	+	+	+	
Technological	+	+	+	+	+	+	+	
Quality system related								+

The study shows that all cases belonging to the Strategy initiative share the same constellation of modeling outcomes, in the form of organizational, economical, project-related and technological benefits. The Dataflow initiatives also share the same constellation of modeling outcomes, in the form of producing both project-related and technological benefits. This suggests that each type of modeling initiative seems to produce the same constellation of overarching types of modeling benefits.

All five modeling initiatives report various modeling gains grouped as project-related in Table 4. Some of them are experienced across different modeling initiatives whilst others seem to be of a more type-specific nature, as for example, the stated benefit "Further involvement in the organization" mentioned by the consultant in the Dataflow initiative, using modeling as a work tool in understanding the client's business. In general what seems common for all initiatives is that modeling is acknowledged as a useful aid in learning and communication during the change process.

Compared to the findings of Indulska et al. (2009), our study confirms several of the benefits ranked highly by practitioners and vendors, such as process improvement and understanding. The latter benefit fits well with what project participants experience in our study when they describe modeling as a thinking tool, as an awareness-raising process in itself and as a common basis for discussion. But some benefits ranked highly by academics, such as model-driven process execution, process simulation and process verification do not appear in our study at all. A possible explanation is that in our study the participants report on what they perceive as advantages of specific acts of modeling, whilst the participants in the Indulska et al. (2009) study seem to report on what they personally see as possible use or usability of modeling also.

Concerning our research design as a multiple case study, Yin (2009) warns that a case study investigator might fail to develop a sufficiently operational set of measures and might use subjective judgments to collect data. To avoid these pitfalls, we have taken steps throughout our research to improve validity and reliability. As previously mentioned we started by developing the EMP research model as an instrument to focus data collection, as suggested by Miles and Huberman (1994). The research model constituted the theoretical propositions of our study and set the scene for the development of our interview guide, which subsequently helped us keep focus in the interviews. To supplement the interview process we collected relevant documents, because multiple sources of material increases construct validity (Yin 2009). To analyze the material we also relied on theoretical propositions, which Yin (2009) describes as the most preferred strategy for data analysis in case study research. We did this by letting the initial categories of our research model constitute the initial constructs in Nvivo as described in the research method section. These precautions do not eliminate a major limitation of any case study, namely the reduced ability to make broad generalizations. This is an obvious limitation of any study that aims to paint a rich picture of EM by investigating modeling practice in-depth and within its real-life context in a limited number of cases. Our study therefore needs to be followed by additional research efforts as described in the further work section.

Conclusion and Further Work

Comparing our findings with the initial research model, we conclude that the study has enriched our initial picture of possible outcomes of EM in ICT-enabled process change. We have also been able to identify five types of modeling initiatives. Our study suggests that benefits of EM depend on the type of modeling initiative in question. This leads to the conclusion that it is important to identify process change main focus, type of ICT-initiative and modeling objectives to be able to determine the type of modeling initiative before trying to give a qualified answer to executive management on the benefits of EM in a specific context.

Our study has also demonstrated that EM in ICT-enabled process change initiatives can produce a variety of benefits. Our findings indicate that the benefits of modeling might very well outweigh the costs associated with what some consider a time-consuming and costly exercise and that modeling should therefore be considered by executive managers as a useful technique. One special finding should be emphasized in this circumstance: perceived benefits of modeling can change over time, as explained by this informant:

"...the support was not great until I realized the point. Terje (the consultant) worked really hard. I remember thinking that this (spending time on EM) was expensive, everything costs a lot of money, fat bills all the time, and then suddenly we saved so much work..." [2. Interview, C1]

This calls for the need of some patience before expecting the true power of enterprise modelling in ICT-enabled process change to appear.

Davenport and Short (1990) state that business process and information technology are natural partners and that organizations that have used IT to redesign boundary-crossing, customer driven processes have benefited enormously. Our study has shown that EM can be a useful technique to gain a good match between ICT and business processes by for example providing a compressed picture of important areas the ICT-solution must meet.

Because we have chosen to compare five cases, one for each identified type of modeling initiative, this presentation can lead to the misconception that we imply that all cases of some type of modeling initiative produce the same variety or number of outcomes. What our analysis does suggest is that cases of the same type of modeling initiative produce the same constellation of overarching types of modeling outcomes (cf. Table 6). We chose to select five cases as representative of the different modeling initiatives to limit and focus our presentation on the benefits of modeling identified in our study.

Based on limitations in our research, especially the number of cases, we see the need for studies focusing on identifying a large number of cases associated with each modeling initiative to generate an aggregated list of possible benefits of each type of modeling initiative. We also see the need for conducting a large survey aiming at identifying all kinds of EM initiatives. We suggest that the end product of the studies should culminate in a classification system of different types of modeling initiatives and expected outcomes. We believe that a classification system of types of modeling initiatives and corresponding benefits of modeling can be of great value in discussions of making and using models in ICT-enabled process change, by making it possible to give more precise answers to managers about the benefits of modeling. In further work we will shift our focus from the benefits of modeling to the context of modeling to further enrich the picture of EM in practice.

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Appendix A

Interview guide

OCHAR=Org. characteristics; PPC=project-participant characteristics; PSC=Project-specific Characteristics;
EM =Enterprise modeling; OC = Outcome

OCHAR 1.	In what industry is the organization where the project is done?
OCHAR 2.	What experience had the organization with process management and process redesign from before this project was initiated?
OCHAR 3.	To what extent has EM been performed earlier in the organization, i.e. before this project was initiated?
OCHAR 4.	In which circumstances?
OCHAR 5.	Which ICT-solutions existed in the organization before this project implementation?
OCHAR 6.	Are people generally prepared to model as part of various ICT development projects?
OCHAR 7.	Has this attitude towards modeling changed as a result of the project implementation?
OCHAR 8.	How then?
PPC 1.	Who do you represent?
PPC 2.	In what connections have modeling work been used before this project was started up?
PPC 3.	What types of business models do you have experience in developing?
PSC 1.	What was the purpose of this development project?
PSC 2.	What type of IT solution should be developed?
PSC 3.	Which development method was followed in this project?
PSC 4.	How can project management be described?
PSC 5.	What resources were available in this project?
PSC 6.	How was the leadership's support in this project?
EM 1.	What existing models did you use in the project implementation? (If no use of existing models: EM1.a. Why did you not use existing models? Go to EM 4.)
EM 2.	In which context were these models created?
EM 3.	How did you use these enterprise models?
EM 4.	Which enterprise models did you make yourselves in this project? (If no then EM 4 a. Why did you not make Any models? Go to Outcome)
EM 5.	Why did you create these models?
EM 6.	How did you use these models?
EM 7.	Did you make the models by using special guidelines?
EM 8.	Which modeling languages were used?
EM 9.	What modeling tools were used to develop the enterprise models?
EM 10.	Was the modeling done in an individual manner or on a group basis?
EM 11.	Who participated in the modeling work ?
EM 12.	How was the participation and involvement when you made models?

EM 13.	How was resistance to modeling work?
EM 14.	Other barriers to modeling?
OC 1.	What are the most important lessons you have made through this project?
OC 2.	What have you achieved in this project in relation to the overall strategies in your business?
OC 3.	How would you say the ability to model has been affected by this project implementation?
OC 4.	What importance had EM and the use of existing enterprise models for these results?
OC 5.	What did you achieve by EM?
OC 6.	How were the processes in the enterprise influenced by the modeling work you did?

Appendix B

Supplemental case information

Case	Main organization	Number of employees	Interviewed* *Those interviewed where those persons our contacts recommended based on an evaluation of their involvement in the projects in general and in modelling activities in special	Organization of modelling activities	Tools
C1	The construction industry, house building	33	The owner and top manager A combined IT-vendor and consultant	Workshops with oral participation meaning that the models were written down by the external consultant while the other participants provided oral inputs to the modelling process	Word Excel
C2	The marine sector, service provider to fish farmers	7	The manager The consultant The IT-vendor	Workshops with oral participation	Visio PowerPoint Excel
C3	The maritime sector, product provider to the maritime industry	7	The top manager The combined IT-vendor and consultant	Workshops with oral participation	Word
C4	The marine sector, laboratory service provider	7	The owner and top manager An employee An consultant	Workshops with oral participation	Word

C5	The off-shore sector, service provider	11	A consultant	Individual modelling; the consultant made the models to reach his job objective	PowerPoint
C6	A wholesaler within the food sector, food distribution	125	A manager within the main organization The combined IT-vendor/consultant involved in the project	Group-based model use of vendor supplied models	Use of vendor supplied models
C7	The banking sector, bank services	1000+	The IT-vendor of the quality system The project manager A person with a central role in the specification of the quality system build-up A person involved in the modelling process from a specific department in the bank Another person from another department also involved in the modelling process An enterprise architect in the organization	Workshops with active participation	Quality sys. application Office app.
C8	The maritime sector, ship building	N/A	A main representative from the IT-vendor Manager Manager	Workshops with oral participation Individual modelling	No specific

III

Enterprise modeling practice in ICT-enabled process change

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Abstract. This paper presents and discusses findings from a study where the use of enterprise modeling has been empirically investigated in eight combined process change and information technology initiatives. Artifacts, guidelines and tools used in enterprise modeling practice are identified. We identify three types of barriers to enterprise modeling: Challenges, Resistance and Moderators. We compare the way the modeling activities are organized with modeling maturity of different groups of project stakeholders. Our results indicate that the distribution of modeling maturity between project stakeholders affects how the modeling activities are carried out.

Keywords: Enterprise modeling, modeling tools, modeling use, barriers to modeling.

1 Introduction

Enterprise modeling can be seen as the art of externalizing knowledge which adds value to the enterprise or needs to be shared, and are often, as done in the following, used as a catch-all title to describe the activity of modeling any pertinent aspect of an organization [1]. Enterprise modeling can be used to represent the structure, behavior, components and operations of a business entity to understand, (re)engineer, evaluate, optimize and control business operations and performance [5, 6].
There are many commercial tools which have come into the marketplace in recent years to assist with architecture visualization and modeling [10]. Persson and Stirna [14] emphasize that while much research has been done on developing enterprise modeling methods, research concerning enterprise modeling in practice has been more or less neglected by the research community. A similar situation can be seen within process modeling, which can be seen as a specialized field of enterprise modeling [20]. Sedera, Gable, Rosemann and Smyth [15] emphasize that while there has been much research on process modeling techniques and corresponding tools, there has been little empirical research into important factors of effective process modeling and post-hoc evaluation of process modeling success.

This paper presents findings from a multiple case study of enterprise modeling practice in ICT-enabled process change. The paper supplements another publication where it is shown that different types of modeling initiatives produce a broad variety of modeling benefits [21]. The paper provides insight and answers to the following research questions:

(1) How is the modeling process organized?
(2) How is participation and involvement in the modeling process?
(3) Which tools, languages and guidelines are used for modeling?
(4) Which artifacts are produced in each type of modeling initiative?

(5) What might influence the selected way of organizing the modeling process as for example workshops with oral participation or workshops with active participation?
(6) Are there any barriers to modeling to be identified?

In the following the paper explains the motivation for our study in section 2. Thereafter follows section 3 explaining how the research project was designed and conducted together with a short description on how the collected research material was analyzed. Thereafter follows section 4 where the questions above are attended, by using the questions as subsection headings. In section 5, our findings are discussed. Finally, in section 6 limitations of our work are emphasized and further work suggested.

2 Motivation

Our research and publication are motivated by both the work of writers like Davenport [3] focusing on information technology as a crucial enabler of process innovation and researchers of modeling practice, here represented by a few:

Davies, Green, Rosemann, Indulska and Gallo [12] conducted a study of conceptual modeling practice using the aspects of conceptual modeling as defined by Wand and Weber [22] to guide their work. Davis et al [12] state that conceptual models are developed and used during the requirements analysis phase of information systems development. Through their study they found that the top six most frequently used modeling techniques and methods were ER diagramming, data flow diagramming, systems flowcharting, workflow modeling, UML, and structured charts. They also found that the highest ranked purposes for which modeling were undertaken were database design and management, business process documentation, business process improvement, and software development.

Persson [13] has described situational factors and their influence on adopting a participative approach in enterprise modeling practice. Through her study she came up with recommendations for use of enterprise modeling in information systems development, particularly in the requirements engineering stages of the development process.

Vernadat [23] has written a book advocating a systematic engineering approach for modeling, analyzing, designing and implementing enterprise systems. In the book a large set of knowledge on tools and methods to achieve business process reengineering and business integration is presented.

Eikebrokk, Iden, Olsen and Opdahl [16] have conducted a study giving insight into Norwegian model-supported process-change practice, focusing especially on process modeling. As part of their study they introduced an a priori process-modeling-practice (PMP) model [17] and a revised PMP model [18]. Their analyses indicate that a combination of technological, social and organizational factors explain the outcome of model-based project change projects.

Motivated by the fact that little is known about enterprise modeling in practice and with an initial aim to test and further explicate the conceptualizations of the PMP model into another setting, our study was initiated to focus on enterprise modeling in ICT-enabled process change. ICT-enabled process change is a term that denotes the use of information and communication technology as an enabler to change the way organizations work, including changes to business processes to make them more efficient and timely and covering the provision of enhanced information to support better decision making [9]. The dual focus built into the term ICT-enabled process change made us, at the onset of our study, expect that different types of enterprise models would be developed and/or used as part of the combined process change and information technology initiatives under study.

3 Research method

Case research is beneficial in the study of ‘why’ and ‘how’ questions because these deal with operational links to be traced over time rather than with frequency or incidence [2]. With our overall research question stated as: ‘How is EM used and how can it be used to support ICT-enabled process change in Norwegian companies?’ it was decided that a multiple case study would serve our purposes. Yin [19] defines a case study as an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.

According to Miles and Huberman [6] highly inductive, loosely designed studies make good sense when experienced researchers have plenty of time and are exploring exotic cultures. On the other hand, Miles and Huberman [6] say, pointing to Wolcott [4], it is not possible to embark upon research without an idea of what one is looking for and it is also foolish not to make that quest explicit.

Looking into an area with little prior empirical research it was decided to develop *a research model for enterprise modeling practice*, building on categories and sub-categories from the related field of process modeling practice incorporating additional aspects found in literature. In addition a pilot study was conducted to provide additional input to the model. By incorporating the PMP model into the research design, we had an additional opportunity to test and further explicate the PMP models conceptualizations into a new setting in accordance with suggestions found in Miles and Huberman [6]. The enterprise modeling practice research model is presented in Karlsen [7].

The enterprise modeling research model was built-up of three main categories: Enterprise modeling (EM), Context and Outcome, where Context was defined as the setting of the project comprising organizational characteristics, project specific characteristics and project participant characteristics and Outcome was defined as the phenomena that follow or are caused by enterprise modeling, including attainment of purpose and the effect of enterprise modeling on the ICT-enabled process change project solution. The EM category, which is the focus of this paper, addresses both the development of new models and the additional usage of existing models in relation to the ICT-enabled process change project.

EM was further elaborated by the subcategories (1) Management support, (2) Modeling Guidelines, (3) Modeling tools, (4) Individual modeling or workshop, (5) Participation and involvement, (6) Resistance, (7) Modeling languages and (8) Modeling artifacts [7]. The work of Eikebrokk et al. [16, 18], Davenport [3], Sedera et al. [15] and Sommar [11], were used to motivate both these definitions and the expected outcomes of enterprise modeling.

Having designed a research model to focus and bound the collection of data, in accordance with Miles and Huberman [6], *we then conducted an exploratory /explanatory multiple case study* on combined process change and information technology initiatives.

We used the telephone and internet to search for relevant cases, and ended up with an study of eight Norwegian cases, defined as a constellation of (1) a main organization or (2) a consulting company and/or an IT-vendor. The main organizations of these cases were related to the construction industry (case C1), the marine sector (cases C2 and C4), the maritime sector (cases C3 and C8), the offshore sector (case C5), a wholesaler within the food sector (case C6) and the banking sector (case C7).

To prepare for the case study an interview guide was developed, containing semi-structured open-ended questions based on the categories of the enterprise modeling research model that was developed in the initial stages of the project. A total of thirty informants were interviewed as part of our investigation, generating 40 hours of tape recordings: two 'expert informants', six informants at the pilot stage to underpin the research model and twenty-two informants related to our eight cases. In addition a rich variety of material was collected in the form of model prints, reports and historical material, as recommended by Yin [19]. Organizational information was additionally downloaded from the internet. We also visited the various companies and got demonstrations of the software solutions involved.

It was decided that a criteria for being included in the study was that the organizations should be “available and willing”, in the sense of being available and willing to provide in-depth insight into enterprise modeling practice via interviews and supplemental information. The second selection criterion was that the respondents defined their projects as ICT-enabled process change.

We had no initial knowledge of the enterprises and their modeling practice at the onset of the study. With such limitations on what to find we chose to use the term enterprise modeling in a broad sense to capture how the companies in fact used modeling; possibly by using both formalized and non-formalized languages, simple tools etc.

All interviews were transcribed and transferred into Nvivo 9, a computer-assisted qualitative data analysis software package, generating more than 500 pages of transcribed text together with links to all other types of material for analysis. Nvivo 9 provided opportunities to run a variety of built-in queries and helped in keeping track of all material collected by providing database facilities.

The research model that originally guided data collection was also used in the initial computer-assisted analysis by providing initial constructs on characteristics of context possibly influencing on the modeling process, constructs on characteristics of the modeling process and the outcome of modeling.

To guide the analysis we used “Qualitative analysis: An Expanded Sourcebook” by Miles and Huberman [6]. This book gives a thorough explanation of coding as analysis, where coding is described as tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study.

The coding process of the interview transcripts started by building a node tree in Nvivo 9 containing the initial constructs of the EMP research model. Then a read through of all interviews was conducted whereby passages of text in the interview transcripts were linked to the appropriate initial nodes. In this process text passages which did not fit the initial nodes were in vivo coded and later specified under new appropriate nodes after a process of revealing appropriate new constructs.

To increase the quality of the coding process the material was re-read to check that nothing important had been missed in the reading process. Missed text sequences were linked to existing or new nodes. Thereafter followed a process where all material linked to each node was controlled to ensure consistency between selected text and the node assigned. Thereafter followed a process where material connected to a particular node was challenged to see if it should be broken into sub-nodes. If a sub-classification seemed appropriate the divide was done.

The coding process ended up with an array of different constructs representing the findings done in conjunction with the questions we raised, concerning characteristics of context possibly influencing on the modeling process, characteristics of the modeling process and outcomes of modeling.

4 Modeling practice

Our initial analysis focused on the case distribution of our eight cases among different constellations of ICT initiatives, process change main focus and modeling objectives. This analysis led to the identification of five different types of enterprise modeling initiatives in our study which we called Strategy, Industry, Dataflow, Work and Support [21].

The ‘Strategy’ initiative (S) was identified and defined as modeling to reach a change strategy in a long term business change initiative with a mixed focus on improving work practice via physical intervention and improving information flows via IT. With reference to the tables and figures in this paper, case C1, C2 and C3 apply to this type of modeling initiative. The ‘Industry’ initiative (I) was identified and defined as modeling to reveal the build-up of market leaders’ IT solutions to develop a joint industry specific IT solution and modeling as input to a preliminary report to communicate the necessary alignment between this joint solution and specific actor needs. With reference to the tables and figures in this paper, case C8 applies to this type of modeling initiative. The ‘Dataflow’ initiative (D) was identified and defined as modeling to reveal AS-IS and as input to a requirement specification in a change effort to improve information flows. With reference to the tables and figures in this paper, case C4 and C5 apply to this type of modeling initiative. The ‘Work’ initiative (W) was identified and defined as utilizing vendor supplied models to reveal differences between a wearable voice-directed warehouse application system and the organization in a change effort to improve work practice by technology. With reference to the tables and figures in this paper, case C6 applies to this type of modeling initiative. The ‘Support’ initiative (Q) was identified and defined as modeling to fill a quality system with process descriptions based on a specific guideline, focusing on developing a business support environment where it is foreseen that in the long run shared common models of work practice will improve business processes. With reference to the tables and figures in this paper, case C7 applies to this type of modeling initiative.

Across our cases a broad variety of different benefits of enterprise modeling were identified in ICT-enabled process change [21]. We will now take a closer look into the characteristics of the enterprise modeling process of each case and type of enterprise modeling initiative under study, thereby answering the research questions used as subheadings in the following.

4.1 How is the modeling process organized?

Analysis identifies different ways of organizing the various modeling activities as shown in Table 1.

At the type of modeling initiative level, Table 1, illustrates that in the Strategy (S), in the Dataflow (D) and Industry (I) modeling initiatives, modeling activities were organized as workshops with oral participation, meaning that the modeling was written down by an external consultant, whilst participants of the main organization provided oral inputs to the modeling process.   This was not the case concerning the Work (W) or Support (Q) initiative.

In the Support initiative they chose to use workshops with active participation in the modeling activity, where employees did concrete mapping of business processes. In addition the quality system initiative was supplemented with the possibility for all employees in the bank to provide inputs to model layouts via a digital mailbox-system named “Supply your input”. The bank also organized a specific user forum where modelers from each business area were represented. The user forum made decisions whether specific process change suggestions collected via the “Supply your input” should be universally applied in the banks’ preferred process portfolio. If so, the corresponding process model in the quality system got changed.

Group based modeling was used in the Work initiative, where a group of representatives from the main organization and external representatives, compared vendor supplied models with what was going on in the warehouse building. Differences were subject to debate and lead to necessary tweaks between system and process layouts.

Table 1. Individual modeling or workshop etc.

	C1	C2	C3	C4	C5	C6	C7	C8
	S	S	S	D	D	W	Q	I
Workshop with oral participation	+	+	+	+	+			+
Workshop with active participation							+	
User forum							+	
Supply your input							+	
Group-based model use						+		
Individual modeling		+			+			+

4.2 How is participation and involvement in the modeling process?

Comparing the cases further indicates that even though people are not directly involved in the actual drawing of the models, their participation and involvement are evaluated as satisfactory or very good in all cases.

4.3 Which tools, languages and guidelines are used for modeling?

By analyzing our cases we identify a varied use of tools, languages and guidelines as illustrated in Table 2.

Table 2. Guidelines, Languages and Tools

Case	C1	C2	C3	C4	C5	C6	C7	C8
Type of modeling initiative	S	S	S	D	D	W	Q	I
Tools:								
The quality system application							+	
Word	+		+	+				
Visio		+					+	
PowerPoint		+			+			
Excel	+	+						
Guidelines:								
Had guidelines	+	+		+	+		+	
Had no concrete guidelines	+		+	+				+
Use of vendor supplied models						+		
Languages:								
Modeling language used		+					+	
Modeling language not used	+		+	+	+	+		+
No specific modeling tool is used		+	+	+		+	+	+

In the construction case, C1, Microsoft Excel and Word are used as the tools for modeling. In the Marine subcontractor case, C2, no specific modeling tool is used, but comes in a flavor of Excel, PowerPoint and Visio made models. In the Maritime subcontractor case, C3, it is stated that no specific modeling tools are used. A model example from the case shows a “rich picture” type of model made in Word. In the Marine laboratory case, C4, Word is identified as the common modeling tool used in the project. In the Off-shore subcontractor case, C5, PowerPoint is the tool chosen. C6 relates to the Work initiative where modeling is defined as utilizing vendor supplied models when implementing a standardized ICT system. In the Banking case, C7, the quality system application itself is used for modeling. In addition one can state that in general no specific modeling tools are used due to a highly varied practice in the bank across departments and project participants. In the Industry case C8 tool use is said to differ between enterprises adopting the industry specific enterprise resource planning solution.

Concerning guideline use, analysis reveals that this can vary along the time-axis of the project lifecycle and among project participants. In the Support initiative they had a common framework on how to build the quality system for modelers and facilitators. They also used external consultants in each business area to make sure that the modeling standard was followed. In cases C2 within Strategy and C4 and C5 within Dataflow, external consultants used a consultant variant modeling guideline in their work. In case C4 employees reported that before the consultant entered the company no concrete guidelines were used. In C1, process description from a similar enterprise was used as a template to set up a description of the company’s own processes. But in general no specific modeling guidelines were used.

Concerning modeling language the majority of cases report that no specific language was used. In cases where modeling language were reported to be used, it turned out that they spoke about some sort of a “consultant variant”.

4.4 Which artifacts are produced in each type of modeling initiative?

Table 3. Artifacts

Case	C1	C2	C3	C4	C5	C6	C7	C8
Type of modeling initiative	S	S	S	D	D	W	Q	I
Process descriptions	+	+	+	+	+		+	+
Meta models							+	
Organization charts		+						
Technological models		+		+	+			*
Adapted models from text books and other sources	+							

With reference to Table 3, analysis shows that in all cases process descriptions are made as part of the process change process (except for the Work initiative where models are used). Technological models are developed in three cases: In C2 Use Cases are developed, in C4 database models are developed and in C5 a system draft evolves in parallel with the development of the process descriptions. In C8, marked with a *, technological models of different solutions were used years ago, when developing the joint industry-specific solution. The construction case, C1, is the only case where models from other sources, textbooks and downloaded documents from the Internet, were adapted to be used as part of the process change process. In one example the consultants adapted a model from a textbook to illustrate to employees in the main organization what they meant by a holistic enterprise understanding.

4.5 What might influence the selected way of organizing the modeling process as for example workshops with oral participation or workshops with active participation?

By comparing the respondents' answers on modeling maturity, the main organization's and the externals' modeling capability and experience of modeling, analysis indicates that in most cases the externals' capability of modeling is seen and reported as high, or at least much higher than what is the situation in the main organization. In one case, C6, the capability and experience with modeling is reported as low both in the main organization and among the externals. In C7 modeling capability is reported as generally high in the main organization, but that it of course varies. In C4 and C8 the capability of modeling in the main organization in general are seen as low, but that there are persons that have some modeling experience from previous projects. By combining these findings with the organization of modeling activities in terms of using workshops with oral participation or workshops with active participation etc., the relationships are revealed as shown in Figure 1.

			Organizational modeling maturity:			
	External			Internal		
Organization of modeling activites:	High	Low	High	Low	Medium_Low	Variable
User forum	C7		C7			C7
Group-based model use		C6		C6		
Individual modeling	C2, C5, C8			C2, C5, C8	C8	
Supply your input	C7		C7			C7
Workshop with active participation	C7		C7			C7
Workshop with oral participation	C1, C2, C3, C4, C5, C8			C1, C2, C3, C4, C5, C8	C4, C8	

Figure 1. Modeling maturity versus organization of modeling activities

The matrix indicates the following relationships between the ways of organizing the modeling activities related to the modeling maturity of different project participants:

(1) In cases where the modeling maturity of the external representative is reported as high and the modeling maturity level of the main organization as low or medium to low, workshops with oral participation are used to organize the modeling efforts. This way of organizing the modeling activities is in some cases supplemented with individual modeling, whereby the external representative sits down and do modeling by him-self based on interview inputs.

(2) In the case where modeling maturity is reported as high both in the main organization and among the external participant, workshops with active participation are used.

(3) In the case where the modeling maturity level is reported as low both in the main organization and among the external participant, group-based model use is applied. In this instance lack of knowledge on modeling does not stop the participants from finding vendor supplied models useful in the project.

4.6 Are there any barriers to modeling to be identified?

In the initial research model 'Resistance' was one of the sub-categories of the enterprise modeling process. Analysis reveals that there are in fact different types of barriers to modeling which we have grouped into: (1) *Challenges*, (2) *Moderators* and (3) *Resistance*. We identify and define 'Challenges' as barriers to modeling related to the actual act of model making. 'Resistance' is identified and defined as negative feelings associated with modeling. 'Moderators' is identified and defined as barriers to modeling that hinder the actual use of modeling in ICT-enabled process change.

Analysis shows the distribution of challenges, moderators and resistance among our cases and different types of modeling initiatives, as illustrated in Table 4, Table 5 and Table 6.

Table 4. Modeling challenges

Case	C1	C2	C3	C4	C5	C6	C7	C8
Type of modeling initiative	S	S	S	D	D	W	Q	I
Conceptual problem related to understanding graphical images							+	

As can be seen from Table 4, Support (Q) is the only initiative where *challenges* associated with understanding graphical images due to conceptual problems is reported.

Concerning the *moderators* of modeling, Table 5, analysis indicates that project participant characteristics, project specific issues, IT system issues, information issues and resource issues influence the modeling process. This is done by moderating, restricting or reducing, the modeling process in the different cases.

Table 5. Modeling moderators

Case	C1	C2	C3	C4	C5	C6	C7	C8
Type of modeling initiative	S	S	S	D	D	W	Q	I
Project participant characteristics:								
Not being good at modeling reduces model making						+		
Knowledge of customers reduces the need for modeling						+		
Lack of historically good experiences with modeling reduces the modeling activity						+		
Some customers are not willing to spend time modeling						+		
Not being good enough to demand spending more time on planning reduces the modeling activity						+		
The fact that we are more directly focused reduces the use of modeling						+		
Project specific issues:								
The history of the project						+		
IT system issues:								
The desire to follow the sheep with the bell with respect to the ICT-solution reduces the need for process mapping								+
The IT system lays down guidelines for the modeling process								+
Information issues:								
Everything cannot be specified (like building a boat)								+
All information needs are not covered by process descriptions		+						
Resource specific issues:								
Available staff:								
Day to day activities are not designed for modeling		+						+

work								
Low staffing levels acts as a limiting factor	+	+						+
Money:								
Our level of ambition	+							
Bad economy acts as a limiting factor	+							
Costs associated with modeling	+		+					
Resource related reviews	+							+
Time:								
Time acts as a limiting factor		+					+	+

Project participant characteristics moderating the modeling initiative: Case 6 is the only instance where moderators associated with project participant characteristics are identified. In general, the main organization in this case works close with one specific IT specialist, serving their general needs for IT services. In this case the use of vendor supplied models is reported as a special event, a specific type of modeling initiative, in the everlasting improvement project where the IT service provider and the main organization live in what is called a symbiotic relationship. In general the IT service provider sees itself as well-informed about their customer and therefore sees little need for making models. The IT provider also pinpoints that a more directly focused work approach reduces the use of models in general. On the other hand, the situation of introducing "voice direction" was something new for all parties, and the vendor supplied models came in handy when the IT provider worked to adapt the organization to the way the system demanded and vice versa.

Project specific issues moderating the modeling initiative: In C6 the IT-provider do see the usefulness of modeling in some situations but emphasizes that in this case the history of the project is important and explains the reduced need for modeling in their day-to-day improvement work with the main organization.

In general, concerning other customers, the IT-provider links reduced use of modeling to instances where customers are unwilling to pay time on modeling, and instances where they as an IT-provider is not "good enough" on demanding such spending.

IT-system issues moderating the modeling initiative: IT system issues are related to case 8, the type of modeling initiative where an industry specific solution is developed and implemented. In this case it is stated that the desire to follow the sheep with the bell, the leading organization in the industry, reduces the need for modeling. The reason is that the industry leader has been markedly engaged in developing the industry specific solution, so their processes are somehow embedded in the IT-solution. It is realized that by implementing the industry specific IT-solution one at the same time adopts the embedded business processes of a marked leader.

Information issues moderating the modeling initiative: Two cases report that their modeling initiative is moderated by information issues, C2 and C8. In C2 it is emphasized that all information needs are not covered by process descriptions and in C8, the case from the maritime sector, it is reported that everything cannot be specified, for example "building a boat".

Resource specific issues moderating the modeling initiative: As can be seen from Table 5 both the Strategy initiative, the Support initiative and the Industry initiative report on lack of resources as a limiting factor on modeling practice.

Table 6. Resistance

Case	C1	C2	C3	C4	C5	C6	C7	C8
Type of modeling initiative	S	S	S	D	D	W	Q	I
Yes, resistance present:								
Some people consider modeling high raving and theoretical							+	
Yes, because our job is to build boats								+
Yes, but the resistance has decreased:								
It was changed when they saw the system in practice						+		
Needed to see the point first	+							
Requires a sales job internally to avoid resistance							+	
The resistance changes from high to low	+							
You need to model a while before people see the point							+	
No resistance:								
Experienced no resistance		+*	+	+	+			

Concerning *resistance*, Table 6 shows that in four out of eight cases no resistance to modeling is experienced. In three of the cases resistance is experienced but has decreased. The reasons why resistance has changed can be seen directly from the table. The only case reporting on an ongoing negative feeling towards modeling is in B8 case, where it is stated that this is linked to what is their job focus; to build boats.

5 Discussion

Comparing our findings with the initial research model leads to an enriched picture of enterprise modeling practice. Concerning our question on how the modeling process is organized, our analysis shows that the EMP research model's category "Individual modeling or workshop" [7] should be more fine-grained to include the following constructs: Workshop with oral participation, Workshop with active participation, User forum, Supply your input, Group-based model use and Individual modeling.

Based on our analysis in section 4.5 on what might influence the selected way of organizing the modeling activities, as for example workshops with oral participation or workshops with active participation, we propose that the distribution of modeling maturity of project stakeholders influence the way the modeling activities are organized.

Concerning our question on participation and involvement in the modeling process, analysis shows that even though people are not directly involved in the actual drawing of the models, their participation and involvement are evaluated as satisfactory or very good. The key to these perceptions might be understood by the reported outcomes of modeling, where modeling is seen as an awareness-raising process in itself, as a communication tool or a thinking tool among others [21].

In [21] a broad variety of different benefits of enterprise modeling associated with the five types of modeling initiatives in our empirical investigation are reported. Looking into the artifacts made and the tools, languages and guidelines used for modeling, our inquiry indicates extensive use of the Microsoft Office application as a modeling tool across cases. In general no specific modeling guidelines are used, except for instances where one finds some sort of "consultant variant" guideline. Concerning modeling language the majority of cases report that no specific language is used. In cases where modeling language are reported to be used, it turns out that they again speak about some sort of a "consultant variant". Concerning which artifacts are produced in each type of modeling initiative our analysis shows that in all cases process descriptions are made as part of the process change process. This finding is not surprising since we have investigated cases which by the interview objects have been understood and defined as ICT-enabled process change.

Comparing the tools, guidelines and languages used for modeling in our study with the modeling benefits produced, we conclude that even the simplest modeling tools and the simplest non-standard model-layouts can provide great value to project participants. The quality system initiative is the only instance where challenges associated with understanding graphical images due to conceptual problems is reported. In addition this is the only instance where it is reported that some see modeling as high raving and theoretical. Modeling to fill a quality system with models to be shared across time and space seem to raise the need for expressing models in a shared syntax [21], as opposed to other cases where models are made as part of a communication process which gives them their immediate meaning.

Despite the various benefits associated with modeling, analysis also reveal three types of barriers to modeling: (1) *Challenges*, (2) *Moderators* and (3) *Resistance*. This finding leads to the necessity to adjust the initial research model which only operated with Resistance as a subcategory. An interesting aspect revealed in the study was the saying that:

"*If you can tie modeling up against initial resistance, modeling actually helps because we can more easily see what the problems are*." [2. Interview, C3]

In this circumstance reduced resistance becomes an outcome or benefit of enterprise modeling.

6 Limitations and further work

Concerning our findings it must be emphasized that our qualitative study has aimed at painting a rich picture of enterprise modeling by investigating modeling practice in depth and within its real-life context. In an attempt to deal with well-known difficulties of case studies we have tried to focus and bound the collection of data by building and using an enterprise modeling research practice model and by applying an interview guide in the field in accordance with recommendations found in Yin and Miles & Huberman [6]. In general our study still is subject to various threats and limitations familiar to case-study research as described in Yin [19] and interviewing as discussed in Kvale [24] who states that the interview is neither an objective nor a subjective method. Focusing on gaining in depth insight from a few Norwegian cases has for instance limited our possibility to make large generalizations. Drawing heavily on related domains or what can be seen as specialized fields of enterprise modeling can be problematic due to context differences when designing a study. In addition, having focused especially on the use of enterprise modeling in ICT-enabled process change has led to a predominance of process modeling in the cases under study. This might be seen as problematic in relation to those who use a more restricted version of the enterprise modeling term: taking a more “total systems” approach, like Fraser [1] discusses.

As a next step in further work we suggest that a revision of the initial enterprise modeling practice research model is in demand, based on the findings of our empirical inquiry; some of which has been the subject of this paper. We also see the need for this revised model to be tested out in situations where projects use enterprise modeling from a more holistic approach than what has been practice in our cases. To increase the ability to make large generalizations we also see the need for large surveys. In such studies we hope our findings can provide useful inputs.

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IV

Enterprise modeling in initiatives that combine process change and information and communication technology

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Abstract. The article presents findings from a multiple case study of enterprise modeling in initiatives that combine process change and ICT. A broadly validated and elaborated model of enterprise modeling practice is presented. The model illustrates how organizational context impacts modeling practice and how modeling practice impacts modeling outcome. The model also shows that the combination of ICT-initiative, Process change main focus and Modeling objectives influence modeling Outcome. It also shows that Type of modeling initiative, Modeling organization, Participation and Involvement, Management Support, Model artifact, Resistance and Modeling maturity are important categories for understanding enterprise modeling.

Keywords: Enterprise modeling, the EMP model, enterprise modeling practice, process change

1 Introduction

Enterprise modeling describes the process of modeling various aspects of an organization (Fraser, 1994), which can support strategic alignment, management of planning evolution and change of business systems and practices (Loucopoulus and Kavakli, 1995). It has been assumed that humans are the main model consumers. Today models are important inputs to business support environments also (White and Miers, 2008).

Much research has been done on the development of modeling methods, frameworks and tools. See for example Kosanke (1995), Schekkerman (2004) and Urbaczewski and Mrdalj (2006). Less is known about enterprise modeling in practice, which this article seeks to remedy.

Our study has focused on enterprise modeling use in initiatives that combine process change and information and communication technology (ICT). This choice was motivated by, among others, Davenport (1993) describing the importance of ICT as an enabler of process change and innovation, Vernadat (1996) advocating an engineering approach for enterprise modeling and Persson (2001) emphasizing the existent knowledge gap on enterprise modeling in practice.

The overall research question was formulated as: *"How is enterprise modeling used and how can it be used to support ICT-enabled process change in Norwegian companies? Context and consequences of enterprise modeling*". The research goal was "*to validate and elaborate the Enterprise Modeling Practice research model*."

In section 2 we present general research on enterprise modeling together with our research on enterprise modeling. Our research method is presented in section 3. In section 4 we present our empirical findings and analyses. The focus is on the identification of various latent patterns and explicit statements supporting or challenging our initial research propositions on enterprise modeling in practice. Based on the patterns and statements identified, a revised enterprise modeling practice

(EMP) model is presented in section 5. The model illustrates enterprise modeling context, practice and outcome and indicates how categories of modeling practice impacts modeling outcome, together with the impacts of categories of context on modeling practice. It is our aim that the revised model enables process managers and others to make better decisions about how to use enterprise modeling in practical projects that combine process change and information and communication technology.

2 Theory

Motivated by the fact that extensive research efforts have been invested into the development of enterprise modeling languages but considerably less effort has been committed to gain knowledge about enterprise modeling practice, Persson (2001) developed a grounded framework of situational factors that affect the applicability and application of participative enterprise modeling, together with a theory on how they influence each other.

Sedera, Gable, Rosemann and Smyth (2004) developed a success model for business process modeling by conducted a multiple case study Their study was motivated by little empirical research on important factors of effective process modeling and post-hoc evaluation of process modeling success.

Davies, Green, Rosemann, Indulska and Gallo (2006) investigated conceptual modeling practice and found, among others, that the six most frequently used modeling techniques and methods were ER diagramming, data flow diagramming, systems flowcharting, workflow modeling, UML, and structured charts.

Kock, Verville, Danesh-Pajou and DeLuca (2009) did a multi-methods study of eighteen business process redesign projects in eighteen organizations and found that attention on communications flows is an important ingredient in successful business process redesign projects.

Recker, Indulska, Rosemann and Green (2010) investigated the ontological deficiencies of process modeling with the industry standard Business Process Modeling Notation. Due to their empirical findings, they highlighted the need for consideration of representational issues and contextual factors in decisions when adopting this notation in organizations.

Eikebrokk, Iden, Olsen and Opdahl (2006) introduced an a priori process modeling practice (PMP) model and a revised model as part of investigating Norwegian model-supported process-change practice. The a priori model indicated that process and modeling maturity influence the modeling process. The model also showed that purpose of modeling and artifacts available influence the modeling process. For short, their analyses indicated that a combination of technological, social and organizational factors explain the outcome of model-based process change projects.

Karlsen (2008) presented an Enterprise Modeling Practice research model to be used to investigate enterprise modeling practice in ICT-enabled process change. The model incorporated and built upon the categories and sub-categories from the study by Eikebrokk et al. (2006), other aspects found in literature and a pilot study of a corporate merger case. The research model was built-up from the main categories <u>Enterprise Modeling</u> , <u>Context</u> and <u>Outcome</u>, where each of these constituted various sub-categories.

<u>Enterprise modeling</u> was defined as "*the set of activities or processes used to develop the various parts of an enterprise model to address some modeling finality*" and constituted the sub-categories: (1) <u>Management support</u>, defined as "*the level of commitment by management in the organization to the modeling projects, in terms of their own involvement and their allocation of valuable resources*", (2) <u>Modeling guidelines</u>, defined as "*a detailed set of instructions that describes and guides the process of modeling*", (3) <u>Modeling tools</u>, defined as "*software that facilitates the design, maintenance and distribution of models", (4) Individual modeling or workshop, defined as "to what extent enterprise modeling is done as a team-work or on an individual basis*", (5) <u>Participation and involvement</u>, defined as "*the degree of*

input from stakeholders, for the design and approval of the models", (6) Resistance, defined as "*a state of mind reflecting unwillingness or unreceptiveness*", (7) Modeling languages, defined as "*the grammar or the syntactic rules of the selected modeling techniques*" and (8) Model artifact, defined as "*a man-made representation of part of an enterprise, for example a process*" (Karlsen, 2008, p. 224).

Context was subdivided into: (1) Organizational characteristics, defined as "*a collective term of those organizational categories that might influence the modeling process*", (2) Project-specific characteristics, defined as "*a collective term of those categories specific to the project that possibly influence the modeling process*" and (3) Project-specific characteristics, defined as "*a collective term of those categories specific to the project that possibly influence the modeling process*" (Karlsen, 2008, p. 223).

Organizational characteristics constituted the subcategories: (1) Process maturity, defined as "*an organization's capability for process management and operation, including available competence and current practice*", (2) Modeling maturity, defined as "*an organizations capability for enterprise modeling, including available competence and current practice*", (3) Technological maturity, defined as "*an organizations capability within the field of ICT; knowledge of existing solutions and knowledge of possible future or other enterprises solutions*" and (4) Culture, defined as "*the organizations readiness to accept and participate in a modeling initiative*" (Karlsen, 2008, p. 226).

Project-specific characteristics constituted the subcategories: (1) Purpose, defined as "*the purpose of the ICT-enabled process change project*", (2) ICT-based future solution, defined as "*a mean to enable process change*", (3) Systems development methodology, defined as "*a standard process followed in an organization to conduct all the steps necessary to analyze, design, implement and maintain information systems*", (4) Project management, defined as "*a controlled process of initiating, planning executing and closing down a project*" and (5) Resources, defined as "*available time, money and people to initiate, plan, execute and close down a project*" (Karlsen, 2008, p. 226).

Project-participant characteristics constituted the subcategory Modeling expertise, defined as "*the experiences of the project participants in terms of conceptual modeling in general*" (Karlsen, 2008, p. 225).

Outcome was defined as "*the phenomena that follow and are caused by enterprise modeling, including attainment of purpose and the effect of enterprise modeling on the ICT-enabled process change solution*", and constituted the subcategories: (1) Ability to act, defined as "*knowledge; ones capacity to set something in motion*", (2) Actual process change, defined as "*the effect of enterprise modeling on processes*", (3) Relative goal achievement, defined as "*the result of the project seen in accordance with overall business objectives*", (4) Eventual process maturity defined as "*changes in an organizations capability for process management and operation*" and (5) Eventual modeling maturity, defined as "*changes in an organizations capability for enterprise modeling including available competence and current practice after the modeling process*" (Karlsen, 2008, p. 225).

The research model constituted a wide array of research propositions on enterprise modeling practice, thereby evoking various directions of further studies, Karlsen (2008).

3 Research method

A multiple case study was chosen because we would investigate a contemporary phenomenon in depth and within its real-life context, and since the boundary between our phenomena and context was not clearly evident (Yin, 1984; Yin, 2009). A multiple case study is a useful method because we study 'why' and 'how' questions that deal with operational links to be traced over time, rather than with frequency or incidence (Benbasat, Goldstein and Mead, 1987). Case study research is also the most frequent applied method in information systems research (Alavi and Calson, 1992; Orlikowski and Baroudi, 1991; Myers and Avison, 2002), and has proved its usefulness in enterprise modeling and the related field of process modeling (e.g. Persson and Stirna, 2002; Bandara and Rosemann, 2005).

We used as a starting point the EMP model, presented in Karlsen (2008) by developing an interview guide with questions derived from the model's categories. The interview guide is presented in Karlsen and Opdahl (2012). During the semi-structured interviews the research model's listings functioned as a check list of topics to be covered and suggested probes to elicit greater detail from the research participants.

The following research propositions were derived from the EMP model:

> *(1) Modeling maturity, Process maturity, Technological maturity and Culture of the organizations influence Enterprise modeling*

Modeling maturity was expected to influence modeling practice due to research by Eikebrokk et al (2006) suggesting this relationship in their study on process modeling practice.

Technological maturity was expected to imply possible restrictions on process design, motivated by Davenport (1993) suggesting this relationship.

Process maturity was expected to influence Enterprise modeling, motivated by Eikebrokk et al (2006) suggesting this relationship.

Culture was singled out as a possible relevant category suggesting that organizations with more organizational readiness to accept and participate in modeling initiatives are likely to be more successful in process modeling projects (Sedera et al., 2004).

> *(2) Modeling expertise of project participants affects Enterprise modeling.*

Modeling expertise: was singled out as a possible relevant category due to Sedera et al.(2004) finding that organizations with more modeling experience are likely to be more successful in process modeling projects.

(3) *Purpose, ICT-based future solution, Systems development methodology, Project management and Resources influence Enterprise modeling.*

Purpose was expected to influence whether modeling was used to support ICT-enabled process change or not, based on findings from the pilot study. The category was also motivated by the PMP study by Eikebrokk et al. (2008) suggesting that purpose influences modeling practice.

Knowledge of ICT-based future solution was expected to influence how processes where shaped, Davenport (1993). In addition Hammer and Champy (1993) described the interconnectedness between information technology and processes as a symbiotic relationship.

Systems development methodology chosen was expected to dictate extent of model making as part of ICT-enabled process change, motivated by the pilot study.

Project management was singled out as a possible relevant category since project management was the most cited success factor in relation to process modeling in Sedera et al. (2004).

Lack of project Resources was expected to lead to reduced use of modeling as part of ICT-enabled process change, motivated by findings from the pilot study.

(4) Individual modeling or workshop in Enterprise modeling contributes to Eventual process maturity.

Individual modeling or workshop: was motivated by Eikebrokk et al. (2008) who concluded that individual modeling or workshop is positively correlated with eventual process maturity.

(5) *Participation and involvement, Management support, use of Modeling guidelines, Modeling tools and Model artifacts in Enterprise modeling contribute to modeling Outcome.*

Participation and involvement was motivated by Eikebrokk et al. (2008) which via quantitative analyses found that participation and involvement is correlated with outcome and Sedera et al. (2004) who concluded that participation and involvement is a process modeling success factor.

Management support was motivated by Sedera et al. (2004), and Davenport (1993) seeing it as vital for success that management is involved and allocate necessary resources. In addition findings from the PMP study by Eikebrokk et al. (2008) showed that management support is significantly and positively correlated with outcome.

Use of Modeling guidelines and Modeling tools was included in the model due to indications of their overall relative importance within a process modeling project, Sedera et al. (2004).

(6) *Resistance in Enterprise modeling is related to Model artifact,* was motivated by Eikebrokk et al. (2008).

(7) *Modeling languages in Enterprise modeling affects Modeling guidelines.*

Modeling languages was included due to indications of its importance within a process modeling project, Sedera et al. (2004). That Modeling languages potentially affects Modeling Guidelines was motivated by findings showing modeling style significantly correlated with modeling framework, Eikebrokk et al. (2006).

(8) *Enterprise modeling leads to increased Ability to act, Actual process change, Relative goal achievements, Eventual process maturity and Eventual modeling maturity.*

Ability to act, in the sense of increased knowledge, was expected to be an important outcome of modeling (Bustard et al., 2000). The term *Ability to act* was motivated by Nico Stehr (2001) describing knowledge as increased ability to act in the sense of increased ability to make good decisions.

Actual process change**,** Eventual process maturity and Eventual modeling maturity: were motivated by Eikebrokk et al. (2006) who found that modeling process has an outcome not only relevant for the process *per se*, but influences the organization as a whole in the form of eventual process maturity and modeling maturity.

Relative goal achievement was included in the model based on Davenport (1993) suggesting that projects leads to various outcomes and Eikebrokk et al. (2006) findings of eventual process maturity and eventual modeling maturity as modeling outcomes. It was suggested that other outcomes could be found also, so we chose the broader term *Relative goal achievement* to catch these instances.

After these initial decisions and preparations, we used the internet and telephone to search for cases. We contacted consultants and IT-vendors, asking if they were involved in change processes that could be of relevance, or if they could provide tips on relevant projects. A criterion for being included in the study was that the organizations should be available and willing to provide detailed information about their enterprise modeling practice. The second selection criterion was that the respondents defined the projects as ICT-enabled process change.

The search led to the investigation of eight cases, each of them a constellation of (1) a main organization or (2) a consulting company and/or an IT-vendor. The main organizations of these cases were related to a home building company with 33 employees (case C1), a fish farmers' service provider with 7 employees (case C2), a product provider to the maritime industry (case C3), a laboratory service provider with 7 employees (case C4),a service provider to the offshore sector with 11 employees (case C5), a wholesaler within the food sector with 125 employees (case

C6), a banking institution (case C7) and two ship builders (case 8) with hundreds of employees.

We interviewed thirty persons: two expert informants, six informants at the pilot stage to underpin the research model, and twenty-two informants connected to our eight cases. In addition much material was collected in the form of model prints, reports and historical material. Organizational information was also downloaded from the internet. By visiting the organizations we received demonstrations of the software solutions involved.

Template analysis was used to organize and analyze our 500 pages of transcribed text and other collected documents. In template analysis the researcher produces a list of codes representing themes in their textual data, where some of these codes usually are defined a priori and then modified and supplemented as the researcher reads and interprets the data material (King, 2004). Our a priori codes were defined by the research model. To enable us to link segments of text to particular themes, to link various sources to coding and to carry out complex search and retrieve operations we used the software package Nvivo. We started by creating a hierarchical tree-structure corresponding to our initial research model.

The tree structure was kept during the coding process whereas sub-codes were adjusted or added as the analysis progressed. In the end a hierarchical tree structure was defined into which all transcripts and supplemental data had been coded. The final structure served as the basis for our interpretation of the dataset and the writing-up of our findings.

To aid in the comparison of the eight initiatives that combined process change and ICT we used built-in query capabilities in the software. To increase our understanding of the research material we supplemented Nvivo with the use of a spreadsheet program while searching for latent patterns in our material. The spreadsheet helped us ensure that each relationship in our initial research model was examined.

We also built a code-structure to keep track of explicit statements in our material of specific relationships between categories of modeling practice. The explicit statements were used to support or challenge our latent analyses.

4 Analysis

We present our material and analysis focusing on the categories of the a priori model on enterprise modeling practice, presented in Karlsen (2008). We start by looking into the model's Enterprise modeling main category and its subcategories in 4.1. Thereafter we focus on Organizational characteristics in 4.2, Project participant characteristics in 4.3, Project specific characteristics in 4.4 and the Outcome of modeling in 4.5. In section 5 we examine the implications of our findings subject to the a-priori model and revise the model accordingly.

4.1 The Enterprise modeling category

4.1.1 Individual modeling or workshop

The sub-category Individual modeling or workshop was broadly confirmed by the present study, which identified the following ways to organize modeling practice: (1) Workshop with oral participation, (2) Workshop with active participation, (3) User forum, (4) Supply your input, (5) Group based model use and (6) Individual modeling.

Workshop with oral participation was found, e.g., in the strategy initiative, where one of the managers describes the modeling sessions in the following manner: *"When I think back on it... I had more the impression that we had brainstorming meetings. Yes, we had one who could this by using a model towards such an active case that we were… It was written down by the chairman. However, it was we ourselves who* *contributed with the input*." [1. Interview, C2]. We defined Workshop with oral participation as "a *modeling activity where employees from the main organization participate in the modeling sessions by providing oral input to the external representative, the consultant, involved in the project*".

Workshop with active participation was identified in C7 where one of the participants describes her experience in the following manner*: "Yes, we had quite a few workshops. We started with the basic process steps. Then we went deeply into each process"* [3. Interview, C7]. The background for active participation in model making is described in the following manner: *"The reason for this was that we believe that you must involve the people who will follow the process by building the process, both to ensure good quality but the involvement and the desire and ability to both improve yourself and to ensure that you follow the processes"* [4. Interview, C7]. Workshop with active participation was defined as *"a modeling activity where selected employees from the main organization take active part in the modeling process by developing models themselves".*

User forum, was identified as a way of organizing the modeling process in C7, where it was described in the following manner: "*It consists of one or two modelers from each business area. They meet regularly and discuss what has been done since the last time, what's new, what do we want to bring with us, for example. So, it's the organization that administrates the modelers. They are a total of between 80 and 90 modelers today.*" [4. Interview, C7]. We defined User forum as *"a way of organizing the modeling activities by providing a meeting arena for modelers".*

Supply your input, was evidenced by the following statement: "*the first they got, in a very early stage, was a type of improvement suggestions system in our tool. And there was also a little motto that to see what the problem is, all employees could go in and make suggestions for improvements on various things. And they have some good ideas that came up and saved them for quite a few dollars*." [Software provider, C7]. We defined Supply your input as *"a way of organizing the modeling activities to involve all employees in the organization in the modeling process, by providing them* *the opportunity to supply their input on possible process change in the model layouts".*

Group based model use, was evidenced in C6 where one of the participants describes modeling practice in the following manner: "*And it's an American company that has made the process descriptions in the first place. They have a lot of finished models that show how the different processes are, how you go through the picking process and the different things you do. And then we went through it, with resource persons, step by step. Is this correct? Is this how you work? We had to look at the process that was set up through the system vendor. So we had to look at: can we use this process? Or do we need to make adjustments*?" [External, C6] We defined Group based model use as *"a way of organizing modeling activities where models are used by a group".*

Individual modeling, was found in cases C2, C5 and C8. Evidence for organizing modeling in this manner is seen for example in the following statement: "*What I see as a result of 2-3 days of interviewing is that it provides me with an overview of the whole. Not only workflow, but I get an overview of business processes and the need for information in different places. And so I take it, sit working on it, noting the real key words in the project. So, they see that I actually write down what they have told me. And N.N. actually got these notes continuously so he could follow what I charted.*" [Consultant, C2]. Individual modeling was defined as *"organization of modeling activities where a single person makes the models by his own".*

Pertaining to the initial suggested relationship between Individual modeling or workshop and Eventual process maturity, our material was checked for this possibility. We found that increased ability to process thinking is not reported in conjunction with individual modeling. On the other hand, in C1 and C7 where workshop is used as an approach to modeling, increased ability to process thinking is reported.

In the banking case, C7, where employees participate actively in modeling it is stated that "*the development of the process expertise has somehow followed the implementation of the business support system*" [C7, 1. Informant], whereas in cases using <u>Workshop with oral participation</u> only one out of five cases report increased ability to process thinking. In this case the consultant says that increased ability to process thinking has evolved over time: "*We put together all employees…made different groups in which a salesman, a construction manager and builders were put together, and told them to find out what they do well and what they do poorly. And when we set this up, there was a chirping mood. It was wonderful to experience: information flow, that's where the shortage is*". [C1, Consultant] "*The organization and the company have gone through a learning process. I mentioned that we were off on a weekend now to work on processes and so on. Previously, I must have pressed hard to get things done. While now the initiative came from the company itself. And then I think that it has led to a change in beliefs*" [C1, Consultant].

What distinguishes C1 from cases C2 to C5 is that this is the only case where adapted textbook models are used in the communication process with the employees to give them additional insight into Lean and holistic enterprise thinking. This might explain the reported increase in ability to process thinking in this specific case. Latent patterns in our data suggest that <u>Modeling organization</u> of activities influences whether increased ability to process thinking is achieved or not among project participants. This is explicitly confirmed in case C2 where modeling with oral participation is used combined with individual modeling by the consultant: *"Then we have a fairly good understanding of the business, and know them in many ways better than themselves. And it enables us to pull out the essence of what are the key challenges facing the business."* [Consultant, C2].

4.1.2 Participation and involvement

Even though people are not directly involved in the actual depicting of the models, their <u>Participation and involvement</u> are evaluated as satisfactory or very good in all cases. We therefore conclude that our case material does not provide a latent pattern suggesting a potential relationship between Participation and involvement and Outcome. To further investigate a possible relationship the case material is searched for explicit statements, found in the quotes: "*if you do not have user participation you will get this kind of...A while ago we went into an organization with the same type of system. In that organization some users simply boycotted the system by not working fast anymore because they had a deal…It is easy for a user to say that it is me who administer the system. It is not the system that administers me. That is a central aspect.*" [IT-vendor, C6]. "*We believe that you must involve the people who shall follow the process by also building the process, both to ensure good quality but also the involvement and the desire and ability to both improve and to ensure that the processes are followed*" [4.interview, C7].

4.1.3 Management support

The importance of Management support was confirmed by the present study, which identified management support as: (1) High and crucial and (2) Management support which increased during modeling practice.

Analyzing our material for latent patterns does not indicate a relationship between Management support and Outcome of modeling, as seen in table 1, in the sense of documenting for example that high degree of management support produces more benefits than in cases where management support is low or not present. In three out of eight cases management support increases as part of modeling, e.g. is influenced by modeling practice. An explicit statement suggesting that Management support influences Outcome is found in the following quote: "*It was soon made clear that in order to make this possible to carry out, it was essential that both the owners and managers were 100% supportive.*" [2. Interview, C2].

		Management support		
		High; Inc.	High; Crucial	
Benefits	APC	C1,C3,C5	C2,C4,C6,C7	*C1,C2,C3,C4,C5,C6,C7*
	Organizational	C1,C3	C2,C6,C8	*C1,C2,C3,C6,C8*
	Project related	C1,C3,C5	C2,C4,C6,C8	*C1,C2,C3,C4,C5,C6,C8*
	Technological	C1,C3,C5	C2,C4,C6,C8	*C1,C2,C3,C4,C5,C6,C8*
	QS related		C7	*C7*
		C1, C3,C5	*C2,C4,C6,C7,C8*	

Table 1: Management support versus Benefits

The following quotes illustrate the increase in Management support as a result of modeling: "*To begin with the support was quite moderate, but then it eventually increased after the conviction that it has something to offer them. Now there are initiatives coming from the managers themselves.*" [C1, Consultant]. "*But support was not big until I understood the point. N.N. worked extremely hard. I remember that I thought that this was expensive, everything costs a lot of money, big bills all the time, and then suddenly we did so much work that one would rather be able to pay them and take free oneself*" [C1, Manager]. We see how crucial management support is considered; the consultant had to work hard to convince management of the importance of enterprise modeling.

4.1.4 Modeling languages and Modeling guidelines

Investigating our material for a latent pattern between the sub-categories Modeling languages and Modeling guidelines of Enterprise modeling shows that in cases where modeling languages are used, modeling guidelines are also used. This applies to C2 and C7. In the other cases no specific modeling languages are used, and the use of modeling guidelines varies widely. We conclude that there is a weak pattern indicating that Modeling language influences use of Modeling guideline.

We present Table 2 to check our material for a possible relationship between Modeling guideline and a possible influence on modeling Outcome.

			Modeling guidelines			
		Varied	Had	Had no guidelines	Use of models	
Benefits	APC	C1, C4	C2, C5,C7	C3	C6	*C1,C2,C3,C4,C5,C6,C7*
	Organizational	C1	C2	C3,C8	C6	*C1,C2,C3,C6,C8*
	Project related	C1,C4	C2, C5	C3, C8	C6	*C1,C2,C3,C4,C5,C6,C8*
	Technological	C1, C4	C2,C5	C3,C8	C6	*C1,C2,C3,C4,C5,C6,C8*
	QS related		C7			*C7*
		C1, C4	*C2, C5,C7*	*C3, C8*	*C6*	

Table 2: Modeling guidelines versus Benefits

We conclude that where no guidelines are used, the same constellation of types of modeling benefits is produced, as in cases where guidelines are used. The same goes for the case where models are used and not made and in cases where practice is varied.

4.1.5 Resistance

Resistance was broadly confirmed as a relevant category, which identified Resistance as "*negative feelings associated with modeling*" experienced in several cases which often diminish as part of the modeling process. One of the respondents expresses this relationship as: "*If you can tie modeling up against initial resistance, modeling actually helps because we can more easily see what the problems are*." [2. Interview, C3]. The IT-vendor in C7 describes the correspondence between Enterprise modeling and Resistance as follows: *"So you go on to draw models that make you see the connection from one side or the other, the different view-points, as an enterprise model can provide. And our experience is that you have to produce a deal before you start to see that "Oh, it's actually a good idea!" ... and when you get to this point, they become very creative".* [IT-vendor, C7]

Moderators were defined as "*barriers that hinder the actual use of modeling in ICT-enabled process change*" (Karlsen, 2011), for example low staffing levels, bad economy and lack of time.

This type of barrier is evidenced in six cases and can be sub-divided into Project participant characteristics, Project specific issues, IT system issues, Information issues and Resource issues, which moderate, restrict or reduce the modeling process. In C6, as an example, the IT-provider do see the usefulness of modeling in some situations but emphasizes that in this case there is reduced need for modeling in their day-to-day improvement work with the main organization. They have lived in a symbiotic relationship with the main organization for many years and therefore have in-depth insight into business processes and business matters which makes modeling excessive.

4.1.6 Modeling tools

Analyzing our material shows that in C1, Microsoft Excel and Word are used as the tools for modeling. In C2, no specific modeling tool is used, but comes in a mixture of Excel, PowerPoint and Visio made models. In C3, no specific modeling tools are used. A model example from the case shows a "rich picture" type of model made in Word. In C4, Word is identified as the common modeling tool. In C5, PowerPoint is used. In C6 vendor supplied models are utilized when implementing a standardized ICT system. In C7, the quality system application is used for modeling. In addition one can say that in general no specific modeling tools are used due to a highly varied practice in the bank across departments and project participants. In C8 tool use differ between enterprises adopting the industry specific enterprise resource planning solution. Based on this we conclude that tools used in the cases can be grouped into: (1) Office, (2) The quality system application and (3) No specific (including writing on paper) and (4) The use of vendor supplied models. Correspondingly, we redefine <u>Modeling Tools</u> as *"devices that aids in the performance of modeling"*.

To check our material for a latent pattern between <u>Modeling Tools</u> and <u>Outcome</u> we make the matrix shown in table 3.

		Modeling tools				
		Office	Use of models	Quality system	No specific	
Benefits	APC	C1,C2,C3,C4,C5	C6	C7		*C1,C2,C3,C4,C5,C6,C7*
	Organizational	C1,C2,C3	C6		C8	*C1,C2,C3,C6,C8*
	Project related	C1,C2,C3,C4,C5	C6		C8	*C1,C2,C3,C4,C5,C6,C8*
	Technological	C1,C2,C3,C4,C5	C6		C8	*C1,C2,C3,C4,C5,C6,C8*
	QS related			C7		*C7*
		C1,C2,C3,C4,C5	*C6*	*C7*	*C8*	

Table 3: Modeling tools versus Outcome of modeling

The matrix indicates a possible pattern between Modeling Tool and modeling Outcome (Benefits of modeling). When the quality system is used for modeling, quality system related outcomes or benefits are achieved, which are different from the benefits experienced using the Office application. For example informant 1 in C7 says of the quality system that: "*we get a list of templates where everything is collected*" and "*it is almost a strategic tool for the entire bank*". Karlsen and Opdahl (2012) list an array of benefits associated with using a quality system as a modeling device. They show that the use of a quality system application can provide benefits beyond model making in Office, which per se is neither a tool for making models available to employees independent of time and space nor a well-developed graphical tool with figure create and display capabilities.

4.1.7 Model artifacts

We identify the following types of model artifacts: process descriptions, meta models, organization charts, technological models and adapted models from text books and other sources.

Analyzing the material shows that in all cases, except from in case C6 where models where used, process descriptions were made as part of the process change process. Technological models were identified in three variants: Use Cases, database models and system drafts. In C2 Use Cases were developed and in C4 database models were developed. In C5 a system draft evolved in parallel with the development of the process descriptions. In C8 technological models of different solutions were used years ago when the joint industry-specific solution was developed. C1 is the only case where models adapted from other sources, textbooks and downloaded documents from the Internet have been used to illustrate to employees in the main organization what was meant by a holistic enterprise understanding.

We do not find a latent pattern between Model artifact and Outcome. On the other hand, explicit statements suggest such a relationship. For example in C1 it is emphasized that the use of theoretically based models can lead to increased understanding [C1, 2. Interview]: "*I showed the model to visualize and to explain on which area we are focusing now. Thus, one thing is that the Board should follow a strategy. The Board should give some led stars etc. for the direction we're going. And so, when we now explain that we are working on the core business. Thus, what is the core business, namely the production of housing is just a tiny little part of it all, and they must understand that it shall be part of a relationship. So, this model was used to describe that. How widely they then ...many of these persons are practitioners and often they think that models are too theoretical. So there can be some skepticism around this. However, it is, I think, useful means to try to explain where you are going and where you are located in the larger context*". Another example is found in C6 where the use of vendor supplied models influences how the technological system and the work practice in the warehouse is aligned, e.g. actual process change: "*they (*e.g. the models*) were governing for how we had to interact with the system. The way we communicated with it and the way we also had to adapt to the IT-system.*" [C6, 2. Interview]. A third example is found in C7 where it is made clear modeling outcome depends on the model type being developed: "*However, you cannot use it as the basis for a detailed specification and development of that type of processes. It is written from the business people so you cannot take advantage of it in a structured IT context*" [5. Interview, C7].

4.2 Organizational Characteristics (OC)

4.2.1 Modeling maturity

We find indications on a relationship between organizational Modeling maturity and Modeling organization of the modeling activities as described in Karlsen (2011).

In instances where Modeling expertise of the external actor is high and Modeling maturity of the main organization also is high, user forum, supply your input and active participation is used to organize the modeling activities. In cases where Modeling expertise of the external is high and Modeling maturity of the main organization is low or medium to low, workshop with oral participation is used. We also find examples of individual modeling, where the external make models as part of his work. In the case where Modeling maturity is low in the main organization and Modeling expertise is low among the external representative, group-based model use is used (Karlsen, 2011).

4.2.2 Process maturity

The sub-category Process maturity was broadly confirmed by the present study, which identified the distribution of process maturity among our cases in the main organization as shown in table 4.

Case	Process maturity
C1	Low
C2	Low; some participants with high process expertise from previous projects
C3	Medium_High
C4	High
C5	Low
C6	High
C7	Participants with high process expertise from previous projects. In general low process understanding of employees.
C8	Varied

Table 4: Distribution of process maturity in the main organization

Investigating for latent patterns between Process maturity and various sub-categories of Enterprise modeling indicates a possible relationship between Process maturity and Modeling organization, as seen in table 5.

		Process maturity			
		Low	Medium	High	Varied
Organization of modeling	Workshop with oral participation	C1,C2	C3	C4	C8
	Workshop with active participation			C7	
	Individual modeling	C5			
	Group based model use			C6	

Table 5: Process maturity versus organization of modeling

The matrix indicates that workshop with oral participation is used when process maturity in the main organization is low or medium. In C4 process maturity is reported as high in the main organization but models are made because "*It is easier to* *give advice when you know what they are doing!"* [C4, Consultant]. When Process maturity is high in the main organization, Workshop with active participation is used. In C5 process maturity is low in the main organization, and the consultant therefore makes the models himself. Group-based models are used in C6.

4.2.3 Technological maturity

Technological maturity was included in the a-priori EMP model based on Davenport (1993) stating that knowledge on existing solutions implies possible restrictions on the process design and how processes are shaped. We find an explicit statement clearly supporting this view: "*when you are modeling you must either in a modeling process be able to make a special designed computer system or you must have sufficient knowledge of a computer system so you can adapt some of the modeling to the standard computer system."* [C1, Consultant].

4.2.4 Culture

Our data did not seem to emphasize cultural aspects of enterprise modeling, so we have therefore removed this category from our model for the time being.

4.3 Project Participant Characteristics (PPC)

4.3.1 Modeling expertise

Modeling expertise was broadly confirmed by the present study which identified the levels of expertise among the external representatives as shown in Table 6.

Case	Modeling expertise
C1	High_Medium
C2	High_Medium
C3	High_Medium
C4	High_Medium
C5	High_Medium
C6	Low
C7	High
C8	High_Medium

Table 6: External representatives' modeling expertise

Modeling maturity of the main organizations is shown in table 7.

The analysis in 4.2.1 showed that Modeling expertise influences EM, and we keep this as a category in the revised model.

Case	Modeling maturity
C1	Low
C2	Low
C3	Low
C4	Low; Medium_Low
C5	Low
C6	Low
C7	High; variable
C8	Low; Medium_Low

Table 7: Modeling maturity of the main organization

4.4 Project-Specific Characteristics (PSC)

4.4.1 Purpose

All our projects are combined ICT and process change initiatives, where the process change main focuses relate to (1) Improving information flow (cases C1,C2,C3,C4,C5,C7,C8), (2) Improving work practice by physical intervention (C1,C2,C3) or (3) Improving work practice by technology (C6,C7). The ICT-initiatives relate to the introduction of (1) A standardized ERP solution, (2) A wearable voice-directed warehouse application, (3) A quality system or (4) An industry specific ERP solution. We therefore operate with the categories Process change main focus and ICT-initiative instead of Purpose in the revised model.

Checking our material for patterns between Process change main focus and categories of EM gives no clear indication of direct relationships. On the other hand, an explicit statement is found: “*The project purpose is decisive to what type of model you need. And the purpose in this case was in fact to have a totals approach to the inner life of the organization. Therefore we had to use a totals approach. In other projects I have been involved in we have for example only looked into core processes or parts of core processes. The reason for that has been that the company itself has identified the problem to be related to those aspects…So again, it is purpose and need of the company that dictates the angle*”[C2, consultant].

4.4.2 ICT-based future solution

As seen in Table 8, a possible latent pattern between ICT-based future solution and Modeling tools is found.

		ICT-initiative: ICT-based future solution				
		Standardized erp	Voice	Quality system	Industry specific	
Modeling tools	Office	C1,C2,C3,C4,C5				C1,C2,C3,C4,C5
	Use of vendor supplied		C6			C6
	Quality system app.			C7		C7
	No specific				C8	C8
		C1,C2,C3,C4,C5	C6	C7	C8	

Table 8: ICT-based future solution versus Modeling tools

When the ICT-based future solution is a standardized ERP solution, Office is used as the modeling tool. When the solution is a wearable voice-directed warehouse application, vendor supplied models is used. When the future solution is a quality system, the quality system itself is used for modeling. Concerning the introduction of the industry specific solution, we are not able to identify a specific modeling tool. This is due to varied practices in the organizations within the industry. An explicit statement is found on the relationship between <u>ICT-based future solution</u> and <u>Modeling tools</u>: *"Firstly, what kind of standard for drawing shall you use, that is one of the challenges. The other is that what you draw shall be more than just a drawing. It shall be put into a repository which is searchable and which you can analyze across and stuff. And that is typically something you do not get through Vision and PowerPoint and the like. Then you should preferably have such an enterprise architecture type of tools as QLM, IDScheer or ARIS and such things."[*C7, 5. Interview]. When the objective is a quality system they need something more than a simple drawing tool.

The interconnectedness between information technology and processes is a symbiotic relationship says Hammer and Champy (1993). To check for a latent pattern between these categories, we investigate the matrix in table 9.

The analysis of the case distribution associated with <u>ICT-based future solution</u> and <u>Model Artifact</u>s produced gives little indication on a pattern similar to what Hammer and Champy (1993) presumably had in mind. It merely indicates that different types ICT-solutions are linked to various types of artifacts produced.

		ICT-initiative: ICT-based future solution				
		Standardized erp	Voice	Quality system	Industry specific	
Artifacts produced	Process descriptions	C1,C2,C3,C4,C5		C7		C1, C2,C3,C4,C5,C7,C8
	Adapted models	C1			C8	C1
	Tech. Models	C2,C4,C5				C2,C4,C5
	Metamodel			C7		C7
	None		C6			C6
		C1,C2,C3,C4,C5	C6	C7	C8	

Table 9: ICT-based future solution versus Model Artifact

To further investigate the possible relationship suggested by Hammer and Champy (1993), we search for explicit statements. The following statements concerning the introduction of future ICT-solutions in the banking case seem to be in support of relationship suggested by Hammer and Champy (1993): "*Sure, they may affect end-user processes in the business areas. It can happen. Then it is the individual business area that on the basis of the ICT-solution can improve the process by giving suggestions to the process owner for this process. The process owner will then make sure that the work process is improved according to what this system can contribute to improvements.*" [1. Interview, C7] Another variant from the same interview is found in the following statement:"*Sometimes it's so that the system is being developed in parallel with a business process becoming more effective, and sometimes it's so that the business process is unchanged, and in such a situation the system should really only be embedded in the business process and that gets less challenging. Then the demand specification and the design shall be shaped to fit into your business process.* "[1. Interview, C7]. We find the following example of an explicit statement in C5 where it is the processes that dictate the ICT-solution:
" *This is the process image, and so we said: in accordance to this we need systems that can address multiple modules in a unified solution, where we say that the base here is to keep track of sales processes, project, product deliveries and customer*

tracking, accounting, payroll, human resources, suppliers and inventory management, procurement, including order, inventory, billing, purchasing. They need the default functionality. So therefore we said that we are going to have a solution that is good at project management, and good at resource and personal projects. We had lots of discussions about how easy it should be for people who sit on the oil platform to place a few hours on a project."[C5, Consultant]

4.4.3 Project management and Systems development

As a result of the interconnectedness between Project management and Systems development we define Project management and Systems development as "*a controlled process of initiating, planning, executing and closing down a project focusing on ICT-enabled business process change".*

The category Project management and systems development showed it's relevant in the present study, where the CI project was described as a gradual year-long process driven by various board directions. In C2, C3, C4, C5 and C8 the project included an implementation plan and a standardized enterprise resource planning solution. In C6 they described their way of project management and systems development as a matter where they "*take a chance that we can do so well, that we are able to see the consequences of what we do*" [C6, Consultant].

We did not find any latent patterns between Project management and systems development and EM. An explicit statement on the other hand indicates a possible relationship between project management and systems development and artifacts produced: "*Can you tell me how you went about to make the quality system? [Interviewer] Yes. We followed the methodology that might have been mentioned N.N. There is a framework for the quality system. This is a framework for modelers and facilitators and is a guide for everyone involved, both on how to model objects, how to model the processes, how to model different aspects of the quality system. And so you have manuals for these players*" [C7, 2.Interview].

4.4.4 Process expertise

We define Process expertise as an *"individual's capability for process management and operation, including available competence and current practice"*. An explicit statements suggesting the relevance of this category is found in the following text passage from the interview with the IT-vendor in C2: "*So you guys are focusing on the information needed related to an extended activity in the compan*y?" [Interviewer] "*Yes. However, in parallel, in the form of the expertise we have, we also supply them with our expertise on how to solve things. In this company we added much to their insight when it comes to inventory and how to purchase items and attach items to a project. They really did not have a good routine on that.*" [C2. IT-vendor] Another example, is found in the following statement, indicating a relationship to EM in terms of process layout (Model artifact): "*My theoretical knowledge of modeling and management tools such as Lean, Balanced Scorecard, etc. has been crucial. I've also had relatively good knowledge about the opportunities in the ERP system.*"[C3, Consultant

4.5 Outcomes of modeling

Coding leads to the identification of four different types of modeling benefits: (1) Actual process change, (2) Project related, (3) Organizational and (4) Technological.

See Karlsen and Opdahl (2012), for information on modeling benefits and the finding that types of Modeling objectives, types of ICT-initiatives and Process change main focus combine in particular ways in our selection of cases, leading to the identification of five different types of modeling initiatives: (1) Support, (2) Strategy, (3) Industry, (4) Dataflow and (5) Work.

We conclude that a variety of relative goal achievements are accomplished by modeling. Obvious examples are "Improved service quality", "An awareness-raising process in itself" and "Further involvement in the organization".

5 Discussion

The main contribution of this paper is a broad empirical validation and elaboration of the Enterprise Modeling Practice research model, presented in Karlsen (2008). We have done several findings detailing the initial picture. An example is the initial category Individual modeling or workshop, where both Workshop with oral participation, Workshop with active participation, User forum, Supply your input, Group based model use and Individual modeling are identified as ways to organize modeling activities.

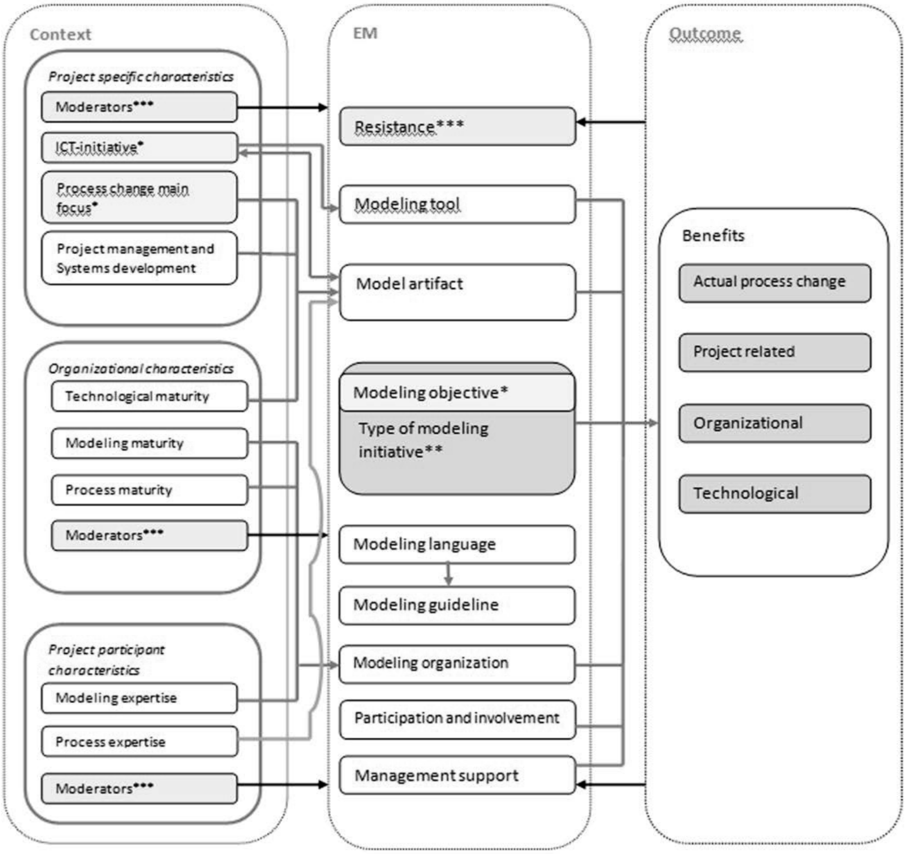
We have found additional categories also, such as Moderators and Modeling objectives, and an array of various benefits of modeling related to type of Modeling initiative in question.

Table A1 to table A6 in Appendix A summarizes the categories of the revised EMP model, their definitions and relationships to other categories in accordance to our findings presented in section 4. The revised EMP model is presented in figure 1, illustrating the complexity embedded in EM practice in initiatives that combine process change and ICT.

Project specific characteristics. The model shows that type of ICT-initiative influences choice of Modeling tool. This was shown in the banking case, where the models made for the quality system required the use of a modeling tool.

A bidirectional arrow is drawn between ICT-initiative and Model artifact showing the symbiotic relationship between the two categories as proposed by Hammer and Champy (1993) and supported in our study.

The revised model shows that Process change main focus influences Model artifacts produced, by dictating which artifacts are in demand and thereby to be produced. It also shows that Project management and systems development influences Model artifact by dictating how to model objects and processes.



****Type of modeling initiative** is defined by the constellation of ICT initiative* (ICT-based future solution) in question, the process change main focus* and modeling objectives*. Types of modeling benefits depend on type of modeling initiative in question. **Barriers** to modeling are marked by ***.

Figure 1: The revised EMP model

Moderators, e.g. barriers that can hinder the actual use of modeling, are found both within Project-specific characteristics, Organizational characteristics and Project-participant characteristics.

Organizational characteristics. <u>Technological maturity</u> influences <u>Model artifact</u> since knowledge on existing solutions implies possible restrictions on the process design and how processes are shaped. The model shows that <u>Modeling maturity</u> influences <u>Modeling organization</u>. This is related to the findings that in situations where modeling expertise of the external actor and modeling maturity of the main organization are high, user forum, supply your input and active participation is used in the organization of the modeling activities etc. The model also pinpoints that organizational Process maturity influences how modeling activities are organized, e.g. Modeling organization.

Project participant characteristics. The model shows that Modeling expertise influences Modeling organization due to the interplay with organizational Modeling maturity as mentioned previously. It also shows that Process expertise of a specific project participant can influence Model artifact produced, by dictating or being decisive for how processes are redesigned.

EM. The model shows that Modeling tool, Model artifact, type of Modeling initiative and Modeling organization influence Benefits of modeling. When the quality system is used for modeling, quality system related benefits is achieved which is different from the benefits experienced using the Office application. The model also shows that benefits of modeling depend on model artifacts produced or used. Type of modeling initiative seems decisive for the type of benefits produced. For example can the use of enterprise models from textbooks increase the employees' general understanding of the organization and its processes. Modeling organization influences whether increased ability to process thinking among project participant is achieved or not.

In the companies we studied the employees in general could not be described as modeling experts. This can explain the use of simple tools in the modeling process.

In the banking case we find an exception from the use of simple modeling tools and languages. Here models are shared via a quality system, creating the need to express the models in a language that can be understood by users distant to the modeler and modeling process.

The model suggests a weak pattern between Modeling language and Modeling guideline since in cases where modeling languages are used, modeling guidelines are also used. It also indicates that Participation and involvement influences modeling

Outcome by being a success factor to ensure that processes are changed or followed as decided.

There is a two-way relationship between Management support and modeling Outcome indicating that Management support influences modeling practice, at the same time as we have found that the production of modeling Benefits increases Management support.

The model indicates that lack of Resources can reduce the EM activity. It also indicates that Outcome of modeling can influence Resistance, since resistance can diminish as part of the modeling process due to increased understanding.

We did not find increased ability to process thinking reported in conjunction with individual modeling. On the other hand, in cases where models were made in workshops, increased ability to process thinking were reported. Project participant involvement thus seems to influence what is learned from modeling initiatives.

Outcome. Finally, the model distinguishes between various types of modeling benefits. In Karlsen and Opdahl (2012) we propose that the combination of ICT-initiative, Process change main focus and Modeling objectives define Type of modeling initiative. In addition we show that various types of modeling initiatives seem to produce different constellations of types of modeling benefits. The model indicates this relationship by an arrow between Type of modeling initiative and modeling Benefits accomplished. Per se this is a finding that underpins the necessity to understand the intricate nature of modeling practice before trying to give a qualified answer on what can be expected by making models in a given project.

7 Concluding remarks

We have aimed at investigating modeling practice in depth and within its real-life context. This has resulted in limitations to our work, familiar to case studies, Yin

(2009). Broad generalizations based on our findings should therefore be made with caution. To increase the validity and reliability of our work we have used a research model and applied an interview guide to focus the collection of data, recommended by Yin (1984), Yin (2009) and Miles and Huberman (1994).

Using a guide to focus our collection of data, have of course led to reduced focus on other factors which possibly also influence modeling practice. An example of a missing aspect can be found in Persson and Sandkuhl (2007) stating that hidden agendas will decrease the possibility of achieving the project goals, since different stakeholders will try steering the project towards their own goals.

Whilst we at times have sensed personal preferences as possible influencing factors, we have excluded them from the revised model, lacking a planned instrument for collecting and evaluating them in a sensible way. An example on a statement where we sense personal preferences and knowledge influencing the "how's" of modeling is found in the following quote: "*What we start with is information flow, goods flow and workflow, and what we see very often is that goods flow and workflow are reasonably good. And that is, I think, because they are visual. You see them. Thus when an item has been in the wrong place, it is realized that we cannot keep on doing it in this way. But, the thing that strikes me over and over again is that when we started working with this company, we had a large meeting where all employees were present, and it was a fantastic atmosphere, because the employees worked in groups. We put together all employees. We sat together the building workers with the building manager and salesperson, and made various groups to find out what we are doing well and what should be changed. And when we put this up, a singing mood evolved. It was amazing to experience, because people saw…it is the information flow! That is where the problem is*!" (Consultant, C1)

Due to this reflection we call for increased focus on <u>Project participant characteristics</u> in future research. A possibility is to focus on power structures between actors and the distribution of knowledge between project participants.

The use of template analysis as a technique for handling our data has also its disadvantages. In particular the technique can result in templates that are too simple to allow deep interpretation or too complex to be manageable. It can also result in the over-descriptiveness and in losing individual participants' voices in the analysis of the aggregated themes (King, 2004). We found the recommendation by King (2004) on the need to impose some shape and structure on the analytic process important. This was done by producing a variety of different matrices to search our material for latent patterns. Each sub-category of Context was matched against each subcategory of EM and each sub-category of EM was matched against categories of Benefits of modeling, e.g. Outcome.

To keep track of and run queries on our material we used Nvivo. By using this software we could run make many checks on our material that otherwise would have been impossible or very difficult.

Time and economy concerns also limited what perspectives on modeling practice to focus on and the number of cases to investigate. We therefore call for more case studies to refine the model, complemented by a quantitative study. Future work should also focus on expanding the model by integrating the findings of more researchers, for example the quality aspects related to artifacts produced in Persson (2001). Only by bringing together the findings of multiple studies a holistic view of the complex nature of EM in practice can be made. In such a setting we hope our work is a useful piece of the puzzle.

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Appendix A

Section	Category	Defined as	Relationship
OC 4.2.1	**Modeling maturity**	An organizations capability for enterprise modeling, including available competence and current practice.	Influences Modeling organization, e.g. in instances where Modeling expertise of the external actor is high and Modeling maturity of the main organization also is high, user forum, supply your input and active participation is used to organize the modeling activities. In cases where Modeling expertise of the external is high and Modeling maturity of the main organization is low or medium to low, workshop with oral participation is used. We also find examples of individual modeling, where the external make models as part of his work. In the case where Modeling maturity is low in the main organization and Modeling expertise is low among the external representative, group-based model use is used.
OC 4.2.2	**Process maturity**	An organization's capability for process management and operation, including available competence and current practice.	Our analysis indicates that level of Process maturity is decisive for Modeling organization.
OC 4.2.3	**Technological maturity**	An organizations capability within the ICT; knowledge of existing solutions and knowledge of possible future or other enterprises solutions.	Influences Model artifact., in the sense that knowledge on existing solutions implies possible restrictions on the process design and how processes are shaped.

Table A1: Organizational characteristics in the revised model

Section	Category	Defined as	Relationship
EM 4.1.1	Individual modeling or workshop. Renamed to **Modeling organization** to show that modeling can be organized in a more nuanced way than initially expected.	The manner in which enterprise modeling can be organized.	Influences Outcome/ Eventual Process maturity, in the sense of influencing whether increased ability to process thinking is achieved or not among project participants.
EM 4.1.2	**Participation and involvement**	The importance of stakeholder involvement and participation in the modeling process, for the design, approval and/or use of enterprise models.	Influences Outcome by being a success factor to ensure that processes are improved or followed as decided
EM 4.1.3	**Management support**	The level of commitment by management in the organization to the modeling projects, in terms of their own involvement and their allocation of valuable resources.	Influences Outcome by being crucial for the making of models as part of process change in the first place. We also find that that modeling Outcome can increase Management support during a project‘s course.
EM 4.1.4	**Modeling languages**	The grammar or the syntactic rules of the selected modeling techniques.	Influences Modeling Guideline, in the sense that where modeling languages are used, modeling guidelines are also used.

Table A2: Categories of EM in the revised model

Section	Category	Defined as	Relationship
EM 4.1.5	**Resistance,** turned out to be a type of Barrier.	Resistance redefined as negative feelings associated with modeling.	Is influenced by Outcome We find that Resistance can diminish as part of the modeling process, but do not find that Resistance relates to Model artifact.
EM New	**Moderators**	Barriers to modeling that hinder the actual use of modeling in ICT-enabled process change.	Influence EM, by hinder the actual use of modeling.
EM 4.1.6	**Modeling tools**	Software that facilitates the design, maintenance and distribution of models.	Our findings support the initial relationship between Modeling Tool and Outcome in the sense that when for example the quality system is used for modeling, quality system related outcomes or benefits are achieved, which are different from the benefits experienced using the Office application.
EM 4.1.7	**Model artifacts**	A man-made representation of parts of an enterprise.	Influence Outcome In one of our cases we find that process design can dictate the ICT-solution.
EM New	**Modeling objective** Introduced as a new category due to our identification of six types of modeling objectives.	The purpose of making models	Influences Outcome

Table A4: Categories of EM in the revised model

Section	Category	Defined as	Relationship
PPC 4.3.1	**Modeling expertise**	The experience of project participants in terms of conceptual modeling in general	With reference to the analysis of Modeling maturity as a sub-category of Organizational characteristics, we conclude that Modeling expertise influences Modeling organization.
PPC New	**Process expertise**	An individual's capability for process management and operation, including available competence and current practice.	Influences Model artifact by dictating or being decisive for how processes are redesigned.
PSC 4.4.1	**Process change main focus*** The initial model operated with the term Purpose	The main purpose, indicated by the main focus, of the combined process change and ICT-initiative.	Influences Model artifact by dictating which artifacts are in demand.
PSC 4.4.2	**ICT-initiative** with the alternative term ICT-based future solution	Mean to enable process change	Influences Modeling tools Influences/Is influenced by Model artifact
PSC 4.4.3	**Project management and Systems development.** The initial model operated with Project management and Systems development methodology as two distinct categories.	A controlled process of initiating, planning, executing and closing down a project focusing on business process change involving the implementation of an information system	Influences Model artifact by possibly dictating how to model objects and processes

Table A5: Project participant characteristics and Project-specific characteristics in the revised model

Section	Category	Defined as	Relationship
Outcome 4.5 New	**Benefits**: Actual process change, Project related, Organizational and Technological	Different constellations of types of modeling benefits are produced by various types of modeling initiatives. A specific type of modeling initiative is defined by types of modeling objectives, type of ICT-initiative and process change main focus.	Is influenced by EM Our analysis indicates that Outcome of modeling depends on Model artifact produced or used, for example in a situation where the use of vendor supplied models influence how the technological system and the work practice in the warehouse is aligned, e.g. actual process change

Table A6: Categories of Outcome in the revised model

Enterprise modeling practice in a turn-around project

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Abstract: The paper describes enterprise modeling practice in a small Norwegian home builder company. The paper contributes to understanding of modeling practice by reporting modeling experiences and recommendations. At an overarching level change happens in three stages: (1) Change maturation, (2) Change decision and (3) Process change, where the last stage constitute four steps of modeling supported process change: (1) Increased business understanding by providing a generic model, (2) Identification of TO-BE by process modeling, (3) Process categorization by sorting models into risk zones and (4) Implementation of prioritized change consistent with model artifacts. Readiness is identified as a precondition both for change and for doing modeling at all. The paper also investigates the importance of employee involvement and anchoring in senior management.

1 Introduction

Enterprise modeling is used in several different ways both by practitioners and in the literature. An enterprise model might be a simple representation of the real world or an abstract picture existing in someone's mind. Anything that represents some enterprise aspect can be considered an enterprise model. It does not have to be anything more sophisticated than a sketch of the plant lay-out drawn on a flip-chart (Szegheo, 2000)

Rumbaugh (1993) describes enterprise modeling as the process of understanding a complex social organization by constructing models. It is a key tool in understanding business processes as a prerequisite for improvement, used as a tool in conversation, communication and understanding in business change programs (Andersen, 2000; White and Miers, 2008). Enterprise modeling supports the strategic alignment task, as well as the management of planning evolution and change of business systems and practices (Loucopoulus, Kavakli, 1995)

While much research has been devoted to the development of enterprise modeling tools, methods and methodologies, less is known on modeling practice, for example on the benefits of process modeling (Eikebrokk, Iden, Olsen, Opdahl, 2008; Indulska, Green, Recker, Rosemann, 2009). Delen and Benjamin (2003) analyzed major obstacles to a broader use of enterprise modeling and analysis methods. Person and Stirna (2001) focused on why enterprise modeling is used. Within a sub-field of enterprise modeling, process modeling, Sedera, Gable, Rosemann and Smyth (2004) provided a success model for business process modeling. Eikebrokk, Iden, Olsen and Opdahl (2006) conducted a study giving insight into Norwegian model-supported process-change practice. They introduced both an a priori process modeling practice model and a revised model. Recker, Indulska, Rosemann and Green (2006) identified critical issues related to the practice of modeling with Business Process Modeling Notation in contemporary process management initiatives. Recker et al. (2010)

highlighted the need for consideration of representational issues and contextual factors in decisions relating to BPMN adoption in organizations. Kock, Verville, Danesh-Pajou and DeLuca (2009) used a multi-method approach to study business process redesign projects in eighteen organizations. They found that a focus on communications flows in business processes is important in successful business process redesign projects. They point out that business process redesign has been intensely studied since the 1990s, but that little attention is paid to the relationship between business process choices and redesign success. Davies, Green, Rosemann, Indulska and Gallo (2006) studied conceptual modeling practice through a web-based survey among the members of the Australian Computer Society. They found the most common purposes for modeling being database design and management, business process documentation, business process improvement, and software development.

To increase knowledge of enterprise modeling practice, we have conducted a multiple case study focusing on enterprise modeling practice in Norwegian companies. More than thirty informants have been interviewed, and a wide variety of materials in the form of model prints, reports and historical material from eight different cases have been collected. Outcomes of the study have been, among others, a model of EMP practice (Karlsen and Opdahl, 2012b) and insight into modeling benefits (Karlsen and Opdahl, 2012a).

Our research has so far aimed at comparing and finding commonalities across various cases. In this paper on the other hand, we use our data to investigate a single case in particular. An inspiration has been Indulska et al's (2009) call for exploration and publication of both success and -failure case studies.

The case we have chosen to present is a project where enterprise modeling was used to turn around a small home builder facing a crisis. This case is interesting because the most recent economic figures show that the company has evolved from risking bankruptcy to becoming a viable market actor.

Section 2 presents related work. In section 3 our research approach is presented. In section 4 the modeling process is investigated and case experiences and recommendations are reported. In section 5 our results are discussed in light of theory. In section 6 conclusions are drawn and suggestions for further research are made.

2. Theory

2.1 EM use

According to Persson and Stirna (2001) enterprise modeling can be used for two main types of objectives: (1) developing the business, e.g. developing business vision, strategies, redesigning the way the business operates, developing the support information systems, or (2) ensuring the quality of the business, e.g. sharing the knowledge about the business, its vision, the way it operates, or ensuring the acceptance of business decisions through committing the stakeholders to the decisions made. Hence, enterprise modeling offers a plethora of potential uses. At a more general level enterprise modeling can be used as a tool for communication, conversation and understanding, and on a more specific level as a tool to develop the business or to ensure business quality.

In Karlsen and Opdahl (2012a) we present our finding of five different types of enterprise modeling initiatives termed Strategy, Industry, Dataflow, Work and Support. Describing each type in terms of process change main focus, modeling objectives and ICT-initiatives gives insight into various "hows" of enterprise modeling. In "Strategy" enterprise modeling is used to reach a change strategy in a long term business change initiative with a mixed focus on improving work practice through physical intervention and improving information flows using ICT. In "Dataflow" enterprise modeling is used to reveal AS-IS as input to a requirements specification in a change effort to improve information flows. In "Work" vendor supplied models are utilized to unveil differences between a wearable voice-directed warehouse application system and the organization in a change effort to improve work practice by technology. In "Support" enterprise modeling is used to fill a quality system with process descriptions based on a specific guideline, focusing on developing a business support environment where it is expected that in the long-run shared common models of work practice improve business. In "Industry" enterprise modeling is used to uncover the build-up of market leaders' IT solutions to develop a joint industry-specific IT solution and to produce input to a preliminary report to communicate the necessary alignment between this joint solution and specific actors' needs.

Among benefits of modeling, we have found enterprise modeling described as a tool or technique to increase the efficiency in the interaction between various project participants leading to a change in operational focus. From a managerial perspective we found enterprise modeling used as a tool or technique for employee training. Concerning project-related aspects, enterprise modeling was described as an awareness-raising process in itself, used to shape a common understanding of the business, functioning as a communication tool leading to increased understanding and reasoning. From a technological viewpoint, enterprise modeling was identified as a tool or technique to produce an image of important areas the IT-system must meet.

Indulska et al (2009) found that academics, practitioners and vendors rank the benefits of modeling differently. Building on Shang and Seddon's (2002) benefits classification framework, they mapped benefits from each top ten list of the vendors, practitioners and academics to one of the five benefit dimensions: (1) Strategic, (2) Organizational, (3) Managerial, (4) Operational and (5) IT infrastructure. They found that the practitioner and vendor groups agreed that process improvement (the greater ability to improve business processes) is the top process modeling benefit. Similarities also existed in the perception of understanding (the improved and consistent understanding of business processes) as a core benefit, being ranked as #2 and #3 respectively by vendors and practitioners. Academics, however, perceived model-driven process execution (the ability to derive process execution code from process models), which was not identified by practitioners at all, as the number one benefit derived from process modeling activities.

2.2 Steps in process change

Davenport and Short (1990), observed most or all of the following steps being performed in companies succeeding with business process redesign: (1) Develop business vision and process objectives, (2) Identify processes to be redesigned, (3) Understand and measure existing processes, (4) Identify IT levers and (5) Design and prototype process.

Kettinger, Teng and Guha (1997) investigated a large number of business process reengineering methods, techniques and tools and placed them within an empirically derived reference framework. They concluded that projects differ in magnitude of planned change, and varying project characteristics calls for differing methodological choices and different techniques. To assist project planners in business process reengineering, they empirically derived a planning framework outlining the stages and activity of a business process reengineering archetype: *Stage 1: Envision.* This stage typically involves a business process reengineering champion engendering the support of top management. A task force is authorized to target a business process for improvement based on business strategy and IT opportunities in the hope of improving the firms overall performance. *Stage 2: Initiate.* This stage encompasses the assignment of a reengineering project team, setting of performance goals, project planning and stakeholder/employee notification and buy-in. *Stage 3: Diagnose*. Diagnose is classified as the documentation of the current processes in terms of process attributes such as activities, resources, IT and cost, where root causes for problems are surfaced and non-value-adding activities are identified. *Stage 4: Redesign.* In this stage new process design is developed by devising process design alternatives through brainstorming and creativity techniques. *Stage 5: Reconstruct.* This stage relies on change management techniques to ensure smooth migration to new process responsibilities and human resource roles. *Stage 6: Evaluate*. This stage involves monitoring of a new process to determine if it meets its goal and is linked to a firm's total quality program. Kettinger et al. (1997) also found that at least 72 techniques were used to accomplish activities associated with business process reengineering projects, including techniques developed in other problem-solving contexts like activity-based costing and role play. They saw that success of radical business process reengineering projects is dependent on effective change management, which places a pressure on project planners to effectively integrate techniques for organizational design into their customized approaches.

2.3 Effective change management

Markus and Benjamin (1997) concluded that many IT-enabled projects fail despite what is known about ensuring success. They argued that failure to employ best practices in ICT-enabled change relates to mistaken beliefs about the causes of change. They did not have a magic solution on how to handle change, but provided some suggestions. First, success in IT-enabled transformation is more likely when those involved in initiating, designing, or building technology-enabled change accepts that IT is not a magic bullet. Good designs and ideas together are not enough to ensure success. Change management involves listening, understanding, giving people an opportunity to learn, designing learning experiments and dramatizing and visualizing ideas. The change management activity must be performed as an integral part of initiating, designing and building change enabled by technology. Markus and Benjamin (1997) recommended that line managers and IT specialists who wish to achieve success with IT-enabled transformation must change their own minds so that they can alter their change management behavior; e.g. giving up the magic bullet theory associated with IT. Next they believed it is unwise to approach such a complex, dynamic and chaotic process as IT-enabled organizational transformation as a linear sequence of tasks with defined roles and handoffs. Instead everyone must be ready to do whatever it takes, since change is everyone's job. To implement this recommendation Markus and Benjamin (1997) suggested that the organizational members learn about and practice all the different roles that change agents can play, e.g. the traditional roles of IT client and expert and the alternative roles of IT facilitator and IT change advocate. They pointed out that all individuals will be more effective contributors to change processes if they learn to shift tactics when conditions change and familiar practices don't work. In addition, they argued that behavioral flexibility is a critical success factor in chaotic change processes, sometimes using a tactic to shock people with evidence of the need for change and sometimes providing them with an attractive vision of the outcomes of change. Visioning change as everyone's job, Markus and Benjamin (1997) proposed that at least two team members should be designated as change agents, e.g. one IT specialist and one non-specialist and that the assignment should rotate periodically so that all team members are able to think through and practice change management. After a shared change culture has started to form, the organization should formalize the role as part of everyone's job. In the job descriptions effective change management performance criteria should be included and weighed in performance assessments of both IT specialists and business people. Markus and Benjamin (1997) concluded that successful change does not need magic, but takes good ideas, skills and plain hard work.

2.4 Readiness

The concept of readiness is well-known within the organizational literature and discussed by for example Beckhard and Harris (1987) and Armenakis, Harris and Mossholder (1993).

Armenakis et al. (1993) emphasized that because of increasingly dynamic environments, organizations are continually confronted with the need to implement changes in strategy, structure, process, and culture. They pointed to Pettigrew (1987) stating that legitimacy for organizational change can be established by interpreting the effects of social, economic, political and competitive factors on an organization's performance, whereas they themselves saw many factors contributing to the effectiveness with which organizational changes are implemented, where one such factor is readiness for change. They described readiness in terms of the organizational members': 1. beliefs, 2. attitudes, and 3. intentions, and defined readiness for change as the cognitive precursor to the behaviors of either resistance to, or support for, a change effort.

Armenakis et al. (1993) saw the message for change as the primary mechanism for creating readiness among members of an organization. They suggested that framing a change project in terms of readiness seems more congruent with the image of proactive managers who play the roles of coaches and champions of change, rather than those whose role is to reactively monitor the workplace for signs of resistance. They asked how a change agent might intervene in the natural flow of social information processing occurring among organizational members to increase their readiness for change. They concluded that the three strategies of persuasive communication (both oral and written), active participation and management of external sources of information are appropriate.

Armenakis et al. (1993) said that oral persuasive communication involves direct, explicit message transmission through meetings, speeches, and other forms of personal presentation, whereas written persuasive communication happen in the form of documents prepared by the organization (e.g., newsletters, annual reports, memos). As to management of external sources, Armenakis et al. (1993) explained that sources outside the organization can be used to bolster messages sent by the change agent, for example in the form of a diagnostic report prepared by a consulting firm used to add credibility to a message sent by the change agent. They emphasized, with reference to Gist (1987) that generally, a message generated by more than one source, particularly if external to the organization, is given a greater air of believability and confirmation.

Armenakis et al. (1993) suggested that active participation in formalized strategic planning activities can lead to self-discovery of discrepancies facing the organization.

3 Research method

The Home Builder case was initially investigated to answer the overall research question: *"How is enterprise modeling used, and how can it be used to support ICT-enabled process change in Norwegian companies?"* The research goal was to elaborate and validate an Enterprise Modeling Practice research model presented in Karlsen (2008).

The overall study has so far led to the identification and revision of a model of enterprise modeling practice (Karlsen and Opdahl, 2012), to the identification of five different types of enterprise modeling projects (Karlsen and Opdahl, 2012a) and to a detailed investigation of outcomes of enterprise modeling (Karlsen and Opdahl, 2012a). The present study on the other hand, examines one of the cases further in depth, in part guided by our overall results. In addition to the data from the overall study, we have used the following sources of evidence:

- financial figures
- a one and a half hour long interview with the project leader

We revisited the company in order to capture the circumstances of and conditions for the organizational change process. This is one of the rationales making single case appropriate, Yin (2009). The revisit additionally introduced another single case rationale; that of the longitudinal case, Yin (2009). We wanted to broaden our insights by focusing on the experiences of a project leader participating in a change project in a typical small company. The assumption was that this could broaden our description of enterprise modeling use by supplementing previous interviews, collected notes, board protocol minutes and other material with personal reflections.

The project leader was our preferred interview object due to his intimate knowledge of the whole change process and his willingness to share these experiences.. He was both member of the Board and consultant engaged to facilitate the turn-around process in the main organization. He acted both as project leader and facilitator of the modeling process.

The last visit resulted in an interview in the form of a dialogue, focusing on three themes: (1) Personal experiences, (2) Recommendations and (3) Lessons learned. The interview gave insight into what the project leader saw as central aspects in the achievements on turning the company into a successful undertaking.

The material was coded with tags or labels for assigning units of meaning to the descriptive or inferential information compiled during the study (Miles and Huberman, 1994). We also re-read all material to gain an overall impression of the change process.

By combining the various sources of evidence we could summarize change in terms of steps and sub-steps.

Experiences, recommendations and lessons-learned were then sorted in accordance to which step they related to.   Finally, case findings were analyzed by comparison to the literature.

4 The history of the Home Builder

4.1 The problems emerge

With reference to signed board meeting protocols, extracts from meeting calendars, correspondence and notes the project leader describes the problematic situation as follows:

In 2002 there was a board meeting where the board director signaled the need for correct information on project results and comparability of financial statements. It was emphasized in the Board meeting that there were formal requirements for project accounting. The formation shown could not be compared to the financial statements, and was made in such a way that it was impossible to calculate break even turn-over or otherwise determine what was good or poor project results. Project accounting thereby lost its significance. [Mail: The history, Project Leader].

In 2005 The Board made the decision to look into the organization. The background was detection of lack of overview on how to make profit while at the same time registering interaction difficulties and conflicts. [Mail: The history, Project Leader].

Early in the year of 2006 the Board decided to review a submitted proposal on the making of clearer distinctions between the activity areas of the company. The way the company was currently managed, one was lacking overview of what made profit. The Board pointed this out. Objection was that it was cost-driving to spend time on this matter and that it seemed unnecessary because the company made money. The board nevertheless made a decision that one should look into how one could obtain relevant information. In the middle of 2006 the company tested a new system for order management, project accounting and financial management. There were still challenges in establishing best practices and good culture for accuracy. One of the challenges was that carpenters got their material on the lumber warehouse without submitting this on the project. In the last month of 2006 the company's organization was again a theme. The arrangement which was put into operation had turned out to be very labor-intensive to follow. It involved that all the invoices that were received on the cost of the inventory had to be registered first, and then withdrawn from the warehouse and brought on to the project. It meant in reality that all invoices for projects had to be registered twice. The Board was impatient and made a decision requiring project accounting presented in a way one could rely on, and reports from the various activity areas. [Mail: The history, Project Leader].

In the middle of 2007 the Board followed the case of ERP and financial overview closely. The report from the Board meeting indicates that the company is in the midst of the change of routines. Order processing seemed to work fine. When it came to the department accounting and project accounting, these systems were expected to be in normal operation by the month of August/September the same year. At the end of 2007 the Board discussed organizing. The outcome of this discussion was splitting the company and the establishment of two separate companies where one should focus on building material and the other should focus on residential design. [Mail: The history, Project Leader].

4.2 The turning-point

In August of 2008 the Bank demanded both operational and liquidity budgets. The company had a line of credit which it had exploited nearly 100%. A new Board meeting was arranged in the middle of the next month. The situation had turned even more serious with a deficit of nearly NOK 1,5 million. The next month the liquidity was reported to be low, but that they expected that they would be able to proceed within the existing frameworks through the rest of the year. The Board emphasized that the procedures which were developed had to be set into operation. Both investment and staffing stop were implemented. Ongoing monitoring and alert duty on revenue was imposed. The Board demanded to be immediately notified if sale figures gave indications that the prognosis of the year would be hampered and not reached. [Mail: The history, Project Leader].

In 2009 the company kept struggling. In a Board meeting at the beginning of October, the Board again discussed routines and interaction within the company. It was evident that there were large opportunities for improvements. The Board decided to have a meeting with all employees, simply asking what they as a company were good at and what they were poor at.

Later the same month the Board invited all employees to a meeting. NN, member of the board and with more than 30 years of experience as “clean-up guy” in companies facing financial difficulties, was designated project leader and facilitator. The meeting started with a discussion on the strengths and weaknesses of the company. A short presentation was then made by the project manager about the principles of Lean and the flow of goods, work flow and information flow. These were subjects that had caught the attention of the project manager during the last couple of years. He therefore wanted the Board to look into them, as possible focus areas of concern to turn the company in the right direction. The employees where then put together in groups with a sales person, a building manager and 2-3 carpenters. They were invited to discuss strengths and weaknesses, the background for the problems, especially in accordance to the concept of flow. A representative from each group summarized the results. The common denominator in what was presented was that the main problem lied in the flow of information.

4.3 A period of process improvements

The company then entered a period where focus was on process improvements; to increase earning through better flows and less errors, to reduce the time usage in the factory and to improve interactions both internally and with suppliers. The Managing Director of the main organization gained the responsibility for implementing the changes. In April of 2010 there was a new meeting with all the employees. Having visited the company several times and interviewed various employees, the project leader wanted to discuss the procedures as they were now present. Again the focus was on the flow of goods, work flow and information flow. [Source: Mail, The history, Project Leader,]:

During the course of process mapping and changing flows, the company's profit after tax increased more than tenfold from 2008 to 2010, from approximately NOK 400' in 2008 to approximately 6000' in 2010. In a meeting with the bank in the middle of 2010 the bank now saw a financially sound company. [Source: Mail, The history, Project Leader,]:

In September the same year, the administration, the Managing Directors, sales personnel, building managers and the project leader had a weekend meeting at a hotel to review the latest process descriptions. The employees had repeatedly been asked for feedback. The review this weekend aimed at concluding on how things should be done. The meeting ended in what the project leader described as their way to build homes on someone else's land.

During 2011 the profit increased even further and was reported as especially high in the end of the year. It is evident from interview statements that a large part of the improved earnings the project participants relate to the modeling process aimed at improving their business process. "*The reason is better information flow, which in turn leads to better goods flow. In addition we are experiencing less scrap due to fewer errors and better workflow due to better information flow: A win-win for all!"* [Interview I, Project leader] "*They discovered that it was necessary to talk to each other and monitor practices and to agree on how to do things, and they saw the strength associated with spending time on these matters*" [Interview I, Project leader]

5 Research findings

5.1 Identifying the modeling process

Based on the history of what happened, we can summarize the change process as three main stages: (1) Change maturation, (2) Change decision and (3) Process change. The change maturation stage lasted for several years, leading to a moment in time where the risk of bankruptcy was evident. The change decision one the other hand was instantaneous when the board acted by deciding to have a meeting with all employees, simply asking what they as a company was good at and what they was poor at. The last stage then took the form of a year-long endeavor where profit increased.

Figure 1 compares Profit margin in industry to Profit margin in the Home Builder case. Figure 2 compares Return on Equity in industry to Return on Equity in the Home Builder case. From the figures we understand that while competitors keep struggling, the Home Builder improves and becomes a viable market actor.

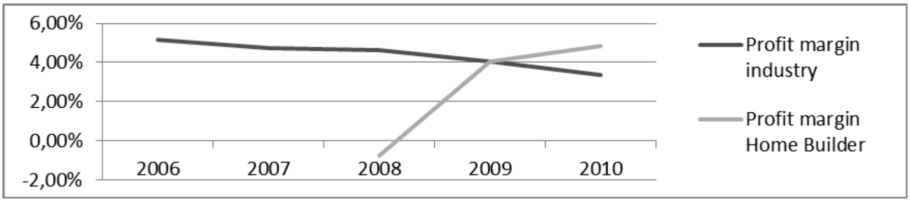

Figure 1: Profit margin in industry compared to profit margin Home Builder

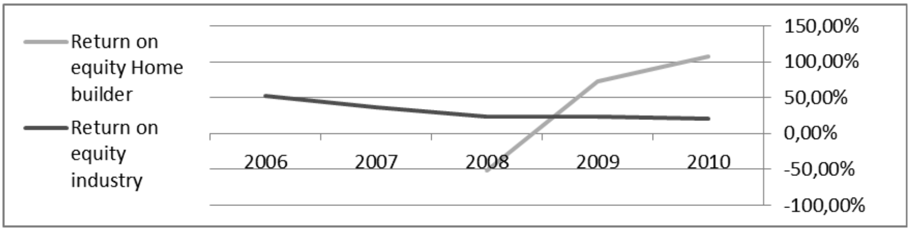

Figure 2: Return on equity in industry compared to Return on Equity in Home Builder

By combining various sources of evidence, process change can additionally be described in terms of four modeling supported steps: (1) Increased business understanding by providing a generic model, (2) Identification of TO-BE by process modeling, (3) Process categorization by sorting models into risk zones, (4) Implementation of prioritized changes consistent with model artifacts, where steps (2), (3) and (4) are iterated.

(1) **Increased business understanding by providing a generic model:** Initially enterprise modeling was used to establish a high level and generic model of the enterprise, using an adapted version of a model found in Miller and Berger (2001).

(2) **Identification of TO-BE by process modeling:** Thereafter followed a process whereby modeling activities were organized as workshops with oral participation. The models were written down by the facilitator while participants of the main organization provided oral inputs to the modeling process. The models were initially produced with the help of MS Excel and Word in the form of a mixture of "home-made" figures and textual descriptions; later on transformed into BPMN (Business Process Modeling Notation).

(3) **Process categorization by sorting models into risk zones:** Having described the processes TO-BE, at large ignoring AS-IS, the processes where then categorized into "*a green, yellow and red zone, where red signals that we do not tolerate deviation whereas in the green zone it is provided more guidance on how to do things",* [Last interview, facilitator].

(4) **Implementation of prioritized changes consistent with model artifacts:** Having categorized the processes, the management of the main organization was instructed to implement the changes. The facilitator describes these activities as follows: "*they adjusted the way they worked…and checked out that the processes had different weights in accordance to risk. We had to be certain that things were done concerning the processes at the critical risk level*"

The project leader [I. interview, Project manager] stated that his expertise did not free the main organization and its employees from their role as providers of insights into business processes so that a more totally integrated picture of the enterprise could be painted by his hands. To emphasize this aspect we use the term "facilitator" when quoting him in the following.

5.2 The facilitator's experiences and recommendations

Increased business understanding by providing a generic model: The reason for starting the modeling effort by providing a high level and generic model of the enterprise was *"to make various employees understand how various enterprise views are inter-linked and how the business processes could be described by introducing the concepts of information flow, work flow and the flow of goods". [Last interview, facilitator].* This approach is seen as an important success factor, because it led to what the facilitator describes as a Eureka experience. The visualization of the enterprise through the generic, high level model made people understand how things flowed "*in the form of goods from the suppliers and on to the construction site*" etc. The tools were important "*to visualize, because again, the flow of goods and work is visual, the information flow is not*!" [Last interview, facilitator]. Besides increasing the competence of the employees concerning how processes interact in the organization, the facilitator also links the use of the general model as a mean to create readiness; to understand why things had to be done and what had to be done.

Identification of TO-BE by process modeling: The facilitator describes modeling practice as a large learning experience for him as well; a process whereby he collected material from various textbooks and from a LEAN course he attended during the course of action. From this he got a "toolbox" of new ideas and approaches on how to accomplish the mission of changing the business.

The facilitator describes the approach used, as follows: "*We started to have workshops. The frequency varied. We brought with us central persons to a hotel for whole weekends and worked to map processes….We discussed the processes: How is it done and how should it be done. We then wrote it down in points. We began monitoring: what happens from the initial stage of planning a house and until producing it, from start to finish? What is going on? Soon it was realized that it was not particularly useful to discuss how they did things, for it turned out that it was* *done in so many and different ways, so it was just as good to go right on: how is it best to do it? And then we started writing that down." [Last interview, facilitator].*

Pertaining to the use of text versus graphical notation *"I feel you should use both. At the early stages of a process using, for instance, BPMN within a group becomes somewhat hopeless in my opinion. It is easier to write a few bullet points on the board to create an understanding of the flow. Entering into the details however, and in the process of accurately describing how to execute things, then BPMN in my opinion is more applicable in terms of visualizing. But just as one is standing center stage, then in my opinion it is better to use words." [Last interview, facilitator].*

Process categorization by sorting models into risk zones: The criteria to associate different processes to the red or the green zone, is explained as follows: *"It is the consequence of the process, i.e. the risk's probability and impact…It is for example: if you do not get the ordered window for a house, you will not get the house weather proof and if you then are about to build the wall..*" *[Last interview, facilitator].* Interviewer: "*So it demands knowledge on construction practice?"* Facilitator: *"Yes, it does!*" The facilitator describes the importance of doing this categorization: *"for in such situations there are many, many actions that shall be executed. And if you map all these actions and describe them in the highest detail, people get totally lost. That is one aspect. The second aspect is that one needs to obtain an understanding that if I do that wrong, then I will detect it and I can fix it by myself". But if I do not execute this process properly, horrific consequences will be the outcome*"**.** *[Last interview, facilitator].*

Implementation of prioritized changes consistent with model artifacts: Improvements where then performed due to an evaluation of which processes where most vital to change. Besides doing concrete improvements on business processes, process descriptions where also put on the wall in the lunch-room. The motive was to ensure that procedures were followed by providing the artifacts on a spot where they would be seen on a daily basis. A concrete implementation of process change was for example the necessity of having the carpenters participating in what is called a triangle meeting before starting a building process, e.g. a meeting between the salesman, the building manager, the carpenter and the customer.

The facilitator emphasizes that a display is not enough to ensure that things are conducted as decided. One also needs someone taking charge. They solved this issue by letting the leader take charge, but "*we still have potential for improvements. And we still experience discrepancies, but less frequent .In any case, one experiences important learning. I also think that many procedures have the tendency to remain in a book on a shelf, and we need to assure that at some point someone must verify that things are executed according to specification." [Last interview, facilitator].* Then, with reference to having published the models on the lunch room walls: *"It is helpful in my opinion, but it comes without guarantee." [Last interview, facilitator].*

As an alternative to having the artifacts at display in the lunchroom, the facilitator suggests that *"Thinking further, instead of using the lunch room wall, maybe we can better describe these processes through illustrations on a computer screen making it easier to look up a point of interest or discussion." [Last interview, facilitator].*

The facilitator also sees the necessity of having modeling competence. He emphasizes that he has *"given some thought to whether anyone can be involved in modeling. I honestly doubt this. It is a matter of ability to view things systematically. I regard myself as systematic. It is also partly a matter of creativity, meaning the ability to identify new ways of doing things. Discussing AS-IS and TO-BE with a group of people, then you both need the ability to understand their descriptions of how things are done, as well as the necessary ability and creativity to think otherwise." [Last interview, facilitator].*

Another important aspect of modeling practice is the type of business at hand: *"modeling is first and foremost suitable in organizations facing repetitive iterative tasks. This must be a recommendation in my opinion." [Last interview, facilitator].*

6 Discussions

In the Home Builder case enterprise modeling was used as a tool to increase the ability to make good decisions, in the short run used in workshops and discussions, in the long run as artifacts hung on the wall and as implementations into well-functioning processes. The focus has been on interaction and process improvements, combined with the introduction of new procedures and an ERP-system. Together these focuses have lead to increased overview, improved flow and better control, where *"at the core of this you find modeling"* [Last interview, Facilitator].

It is acknowledged that how the employees and the executive management behave on a daily basis influences the result. The role of strategic management is also seen as important. This is in line with Markus and Benjamin (1997) emphasizing the need for several organizational member roles in change processes, and Kettinger et al. (1997) stating that project success is dependent on effective change management.

Previously we interviewed one of the managers saying that modeling "*support was not big until I understood the point. N.N. (the facilitator) worked extremely hard. I remember that I thought that this would become expensive, everything costs a lot of money, big bills all the time, and then suddenly we saved so much work that we rather could pay them and take time off ourselves. You understand what I mean? And as I see it now: spending some money on it, I do not see it as an expense but as a mean to increase income. Because now I believe in it, and then it is much easier!*" [1. Interview, Manager]. From this and similar statements it is evident that the facilitator has put a major effort into selling the idea of mapping the business processes to be able to understand what to do and what to change. Visualization through a generic, high level enterprise model helped people understand how things flowed in the form of goods from the suppliers and on to the construction site etc. The use of a generic model increased readiness further, by improving the ability to understand why things had to be done and what had to be done. These actions fit well with Armenakis et al (1993) suggestions on readiness creation through arguing and discussing. At the same time, based on the board protocols, we see how the company's situation is deteriorating, leading to a maturity state where it is evident that something has to be done. This is another factor described by Armenakis et al. (1993) shaping readiness via solid evidence.

Having increased business understanding by providing a generic model, the three iterative stages of identifying future state, process categorization and implementation of prioritized changes were entered. Davenport and Short (1990) emphasized that the means by which processes to be redesigned are identified and prioritized is one of the key issues in process redesign. They also saw two major approaches to the issue, where they labeled the first the "exhaustive" approach and the second "high-impact". The exhaustive approach attempts to rigorously identify all processes within an organization and then prioritize them in order of redesign urgency. The high-impact approach attempts to identify only the most important processes or those most in conflict with the business vision and process objectives. Comparing these approaches to what was done in our case we see that the high-impact approach is chosen. This choice can be understood by the challenges the company was facing. They had to act as quickly as possible, and they did, by focusing on aspects considered most grave. In fact, they focused on information flow, which lead to better goods flow and experienced "*less scrap value due to better information flow: A win-win in all ends!*" [1. Interview, facilitator].

The change of processes, by physical intervention and design of the ERP system to support business improvement, was then followed up by making model artifacts available in the lunch room. The motive was to ensure that procedures were followed by placing the artifacts where they could be seen on a daily basis. But, the facilitator experienced that model provision was not enough. In fact, someone had to make sure that things were done in a proper manner. The facilitator saw the need for the company manager to take an active role in ensuring that things where followed up, e.g. he had to function as the second change agent, besides the facilitator himself. This is in line with Markus and Benjamin (1997) who recommended that at least two team members should be designated as change agents and that after a shared change culture has started to form, the organization should formalize the role as part of everyone's job.

Comparing the process change sub-steps in this case with the steps observed by Davenport and Short (1990) in successful process redesign, we conclude that there is a rather good match between the two. In line with Davenport and Short (1990), we notice that the facilitator uses time on developing shared vision and process objectives by educating various employees on the need for process interaction and orchestration. Next, the processes to be redesigned are identified focusing on TO-BE, equal to the second step in Davenport and Short (1990). Thereafter process risks are categorized, which fits the step of understanding and measuring existing processes in Davenport and Short (1990). When it comes to the implementation step, where the ERP system is adjusted together with physical intervention in selected processes, this largely fits Davenport and Shorts' (1990) observation of identifying IT levers and design and prototype processes. There is also a good match with the stages in the reengineering archetype presented by Kettinger et al. (1997). Regarding their first stage focusing on involving a business process reengineering champion to gain support of top management, we find this an activity performed in the home builder case also. As regards the second stage on encompassing the assignment of a reengineering project team, setting of performance goals, project planning and stakeholder/employee notification and buy-in we see that this is something the facilitator also engage in, but more one an iterative basis through the change process together with the three next stages described by Kettinger et al. (1997). The *Evaluate step*, which is not made explicit in the steps described by Davenport and Short (1990), is seen performed when the facilitator produced financial figures and compared them with similar companies in the same sector.

Due to the similarities between actions performed in the home builder case and the steps envisaged by Davenport and Short (1990) and Kettinger et al. (1997), we conclude that steps taken explain project success together with enterprise modeling used to support change.

7 Concluding remarks

Having described enterprise modeling practice in a small Norwegian home builder company, we have contributed to increased insight into a successful process change project. By combining various sources of evidence, we were able to describe change at an overarching level in three stages, where the last stage constituted four steps of modeling supported process change. Readiness has been identified as a precondition both for change and for doing modeling at all. The paper has also demonstrated the importance of employee involvement and senior management anchoring.

In general, the single case study was motivated by the need for more in-depth insights into modeling practice in specific projects. The choice of method is supported by Yin (2003), stating that case study research can add increased insights, by retaining the holistic and meaningful characteristics of real-life events. We have therefore put in an extra effort to reconstruct the change process and the modeling process by using various sources of documentation. Since individual participants' voices are in danger of being lost while comparing cases (King, 2004), as we did in the overall study, we have tried to amass the facilitator's experiences and recommendations.

Despite the ability of broadening the picture of a social event, case study research also has various limitations, (Yin , 2009). We therefore call for other methods to supplement our work. An example can be a large survey examining whether the recommendations and experiences reported in this paper is shared in other projects. Whatever research approach followed, we share with Indulska et al. (2009) a wish for further research on modeling experiences in real-life projects.

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