Enterprise Modeling Practice in ICT-Enabled Process Change

Anniken Karlsen

Enterprise modeling practice in ICT-enabled process change

Anniken Karlsen[1,2]

[1] Department of Engineering and Maritime Studies, Aalesund University College, Norway
[2] Department of Information Science and Media Studies, University of Bergen, Norway

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 inquiry 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 was 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 inquiry, 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 inquiry 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 inquiry. 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.

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		+			+			+

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.

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.

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.

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		+					+	+

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.

References

1 Fraser, J.: Managing Change through Enterprise models. In Milne, R. and Montgomery, A. (eds), Applications and Innovations in Expert Systems II, SGES Publications (1994).

2. Benbasat, I., Goldstein, K. D., & Mead, M.: The case research strategy in studies of information systems. In M.D. Myers, & D. Avison (Eds.), Qualitative research in information systems: a reader. London: Sage (2002)
3. Davenport, T.: Process innovation: reengineering work through information technology, Harvard Business School Press, Boston (1993)
4. Wolcott, H.F.: Differing styles on on-site research, or, "If it isnt't ethnography, what is it?". The review Journal of Philosophy and Social Science, 7(1&2), 154-169 (1982).
5. Vernadat, F. B.: Enterprise Modeling and Integrations, principles and applications, Chapman & Hall, London, UK (1996)
6. Miles, M.B., Huberman, A.M.: Qualitative data analysis – an expanded sourcebook. Sage Publications (1994).
7. Karlsen, A.: A Research Model for Enterprise Modeling in ICT-enabled Process Change. In Stirna, J. & Persson, A.: The Practice of Enterprise modeling. Lecture Notes in Business Information Processing. LNBIB 15. Springer (2008)

8. Petrie, C. J. jr. (ed.): Enterprise Integration Modeling, Proceedings of the First International Conference, Scientific and Engineering Computation Series, The MIT Press, US (1992)
9. Manwani, S.: IT-Enabled Business Change, Successful Management, The British Computer Society, Publishing and Information Products, UK (2008)
10. Nightingale D. J., Rhodes, D. H.: Enterprise Systems Architecting: Emerging Art and Science within Engineering Systems, MIT Engineering Systems Symposium, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA (2004)
11. Sommar, R.: Business process modeling introduction, tutorial, developed by KTH (2006)
12. Davies,I., Green, P., Rosemann, M., Indulska, M., Gallo, S.: How do practitioners use conceptual modeling in practice? Data & Knowledge Engineering, Volume 58, Issue 3, September, Pages 358-380 (2006)
13. Persson, A.: Enterprise modeling in practice: Situational factors and their influence on adopting a participative approach. Ph.D. Thesis. Department of Computer and Systems Sicences, Stockholm University/Royal Institute of Technology, Sweden, Report series No. 01-020 (2001)
14. Persson, A., Stirna, J.: Why Enterprise Modelling? An Explorative Study into Current Practice. In: Dittrich, K.R., Geppert, A., Norrie, M.C. (eds.) CAiSE 2001, vol. 2068, p. 465. Springer, Heidelberg (2001)
15. Sedera, W., Gable, G., Rosemann, M., Smyth, R.: A success modell for business process modeling: findings from a multiple case study. In: Proceedings Eight Pacific Asia Conference on Information Systems, Shanghai, China, pp. 485-498 (2004)
16. Eikebrokk, T., Iden, J., Olsen, D., Opdahl, A.: In Process Modelling Practice: Theory Formulation and Preliminary Results, NOKOBIT, Molde, Norway (2006)
17. Iden, J., Olsen, D., Eikebrokk, T., Opdahl, A. L.: Process change projects: a study of Norwegian practice. In: Proceedings of ECIS, Gotenburg, Sweden, pp. 1671-1682 (2006)
18. Eikebrokk, T. R., Iden, J., Olsen, D., Opdahl, A. L.: Exploring Process-Modelling Practice: Towards a Conceptual Model. Proceedings of the 41st Hawaii International Conference on System Sciences (2008)
19. Yin, R. K.: Case study research: Design and methods, Fourth Edition, Applied Social Research Methods Series, Volume 5, Sage (2009)
20. Andersen, B.: Enterprise Modeling for Business Process Improvement, Chap. 10, p 137-157 in Enterprise Modeling: Improving Global Industrial Competitiveness, Kluwer Academic Publishers, USA, edited by Rolstadås, A and Andersen, B. (2000)
21. Karlsen, A, Opdahl, A. L.: Benefits of different types of enterprise modeling initiatives in ICT-enabled process change. Manuscript submitted for publication.
22. Wand, Y., Weber, R.: Research commentary: information systems and conceptual modeling—A research agenda, Information Systems Research 13 (4) (2002) 363–376.
23. Vernadat, F.B.: Enterprise Modeling and Integrations, principles and applications. Chapman & Hall, London (1996)
24. Kvale, S.: Interviews: an introduction to qualitative research interviewing, Sage Publications (1996).