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 (EM) practice in information and communication technology (ICT) enabled process change. This paper presents a research model to be used in a project investigating the use of EM in ICT-enabled process change in Norwegian west coast enterprises. Building on categories and sub-categories from the field of process modeling, the model constitutes a wide array of propositions concerning EM practice, thereby evoking various directions of further inquiery.

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

1 Introduction

According to Persson and Stirna [1], research concerning enterprise modeling practice has been more or less neglected by the research community. Focus has instead been placed 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. [2,3] named the Process Modelling Practice (PMP) study.

In this paper an enterprise modeling practice (EMP) research model is presented, showing possible categories influencing or 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 applied in a study of enterprise modeling use in ICT enabled process change. Empirical evidence will be gained through cases concerning 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. Since most sources relate their work especially to process modeling practice and not the broader scope of enterprise modeling, it becomes essential to emphasize that the categories and relationships of the EMP model constitute a set of propositions/hypotheses in future enterprise modeling practice research where it is inititally assumed that what yields for process modelling yields for enterprise modeling practice also.

One faces challenges both in the ICT industry and in and between enterprises implementing new ICT systems to facilitate processes [4,5,6,7,8,9]. 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 [10,11]. Henderson [12, page 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 [13], 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 [13,14].

Vernadat [15] 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 assembly of models [14], for example organization models, process models, data models, configuration models and plant layout models [13].

According to Vernadat [15] 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. [15, page 70]. Supporting this view, Kalpic & Bernus [16] 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 [10], enterprise views such as the executive leadership view, the processes view and resources 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 [17]. 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 [10, page 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 [18,19]:

- 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 [20] 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 [20]. 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 [20].

The MUST method [20] 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 . 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" [7, page 142].

2.3   The PMP Model

Iden, Eikebrokk, Olsen & Opdahl [2,21] emphasize that process change, in various incarnations, has been a central topic in the IS field for several decades. Their study, named the process-modeling practice (PMP) study, give insight into Norwegian model-supported process-change practice, focusing especially on process modeling. As part of their study they introduce The a priori PMP model [22], figure 1, and The Revised PMP model [23], figure 2.

The a priori 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.

The revised PMP model focuses on how Modelling processes and Process competence are related to the Outcome of model-based process change projects, where Process Modeling competence corresponds to Initial process-modelling maturity in the a priori model and Process-orientation competence corresponds
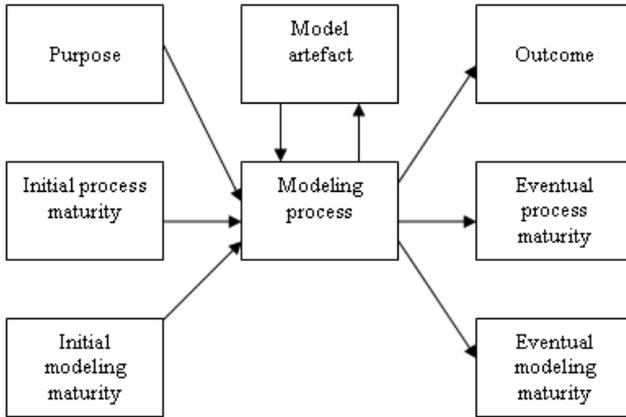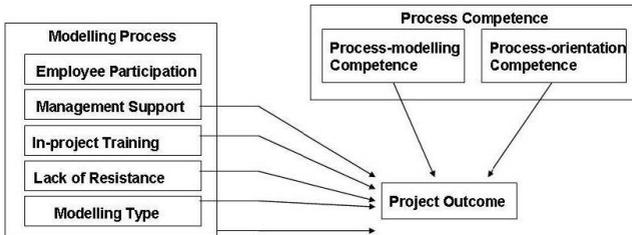
Fig. 1. The a priori PMP model

Fig. 2. The revised PMP model

to Initial process maturity in the initial model. The revised model has retained the Modeling process construct in the a priori model; defined as the "activities carried out within the project to improve the organization's processes" [23].

From the initial study the following constructs are kept as dimentions of the modeling process: Employee participation, Management support, In-project training, Lack of resistance and Model type. In the revised model Project outcome is brought in as an main variable decomposed into the dimensions: Goal achievement, Organizational impact, Process-orientation learning and Process-modeling learning [23].

Eikebrokk et al. [23] states that a central hypothesis is confirmed in their study: There is a positive relationship between modeling processes in terms of management support, lack of resistance, in-project training, model types and project outcome.

For short one can sum up that their analysis indicates that a combination of technological (i.e. Model type), social (i.e. Lack of resistance) and organisational factors (i.e. Management support) explain the outcome of model-based

process-change projects, being aware that their present study cannot exclude the importance of additional dimensions of Modeling process [23].

A motivation for being occupied with modeling in projects is that quantitative and qualitative analysis in the PMP study [3] 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.
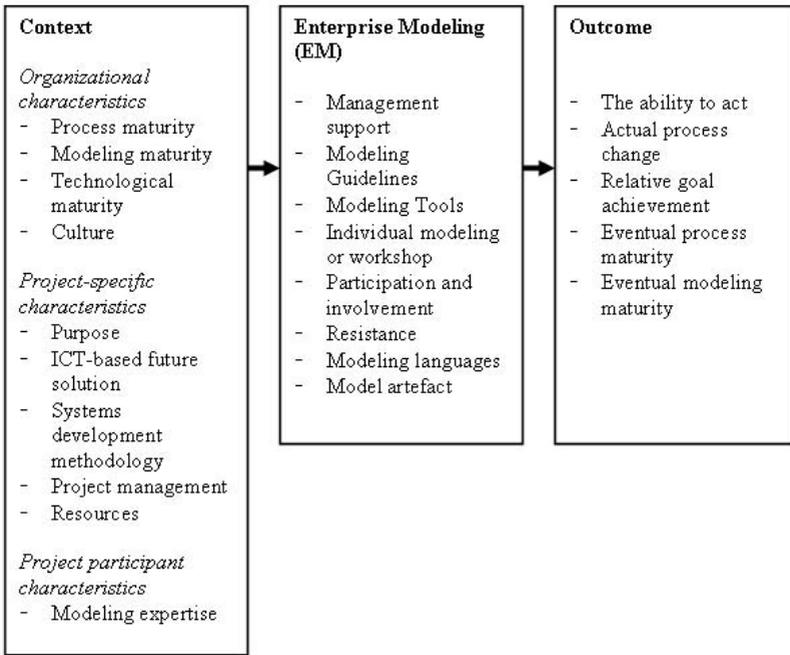
3   The EMP Research Model

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 [2,3], findings from the PMP study, aspects found in literature, especially in relation to the writings of Davenport [19] and Sedera et al. [24], and a pilot study of a corporate merger case[25]. Concerning the EMP model the merger case indicated that the categories project resources, project purpose and systems development methodology might influence on the modelling 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. The findings from the pilot study, which will be further examined, can be found under Context, table 4, in the EMP model. In section 4 the PMP and the EMP study are compared and discussed.

Figure 3 shows the enterprise-modeling practice (EMP) model that has been developed.

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 [15]. 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 [15] 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, where the column named 'Motivation/Sources' gives references to the sources that motivates the categories and relationships of the EMP model.

Context	Enterprise Modeling (EM)	Outcome
Organizational characteristics - Process maturity - Modeling maturity - Technological maturity - Culture *Project-specific characteristics* - Purpose - ICT-based future solution - Systems development methodology - Project management - Resources *Project participant characteristics* - Modeling expertise	- Management support - Modeling Guidelines - Modeling Tools - Individual modeling or workshop - Participation and involvement - Resistance - Modeling languages - Model artefact	- The ability to act - Actual process change - Relative goal achievement - Eventual process maturity - Eventual modeling maturity

Fig. 3. The EMP model

The sub-categories of the main category Enterprise Modeling are mainly linked to findings from the PMP study, where quantitative analyses [2] show that:

- management support is significantly correlated with outcome
- individual modeling or workshop is correlated with eventual process maturity
- participation and involvement are correlated with outcome
- modeling languages are correlated with modeling framework
- resistance is negatively correlated with model artefact

Sedera et al. [24] among others emphasize the relevance of Modeling Guidelines and Modeling Tools.

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. The a priori PMP model points to process maturity and modeling maturity as possible relevant categories.

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

Table 1. Enterprise modeling practice; Enterprise Modeling.

Category	Definition	Motivation/Sources
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. [24])	Eikebrokk et al. [3]; Davenport[19], Sedera et al. [24]
Modeling Guidelines	A detailed set of instructions that describes and guides the process of modeling. (Based on Sedera et al. [24])	Sedera et al. [24]
Modeling Tools	Software that facilitates the design, maintenance and distribution of models. (Based on Sedera et al. [24])	Sedera et al. [24], Sommar [26], Eikebrokk et al. [3]
Individual modeling or workshop	To what extent EM is done as a team-work or on an individual basis. (Based on Davenport [19])	Davenport [19] and Eikebrokk [2]
Participation and involvement	The degree of input from stakeholders, for the design and approval of the models. (Based on Sedera et al. [24])	Eikebrokk et al. [3], Sedera et al. [24]
Model artefact	A man-made representation of parts of an enterprise, for example of a process. (Adapted from Eikebrokk et al. [2])	Eikebrokk et al. [2]
Resistance	A state of mind reflecting unwillingness or unreceptiveness. (Adapted from Hultman [27])	Eikebrokk et al. [3]
Modeling languages	The grammar or the syntactic rules of the selected modeling techniques.	Eikebrokk et al. [3]

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 [24], 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. [24] 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 participant characteristics in

Context, and table 4 shows sub-categories of project-specific characteristics in Context.

The sub-categories of the main category Context can be linked to different sources. For example are Process maturity and Modeling Maturity known from the PMP study, where qualitative analysis indicates weak patterns between high initial process maturity and modeling maturity, and weak patterns between high initial process maturity and modeling maturity. Sedera et al. [24] make clear the importance of culture, modeling expertise, and project management in their work, whilst for example technological maturity is associated with Davenport [19] stating that knowledge of existing solutions implies possible restrictions on the process design and that knowledge of possible future solutions might influence how processes are shaped.

Outcome. 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

Table 2. Enterprise modeling practice; Context; Organizational characteristics

Category	Definition	Motivation/Sources
Process maturity	An organization's capability for process management and operation, including available competence and current practice. (Adapted from Eikebrokk et al. [2])	Eikebrokk et al. [2]
Modeling maturity	An organizations capability for EM, including available competence and current practice. (Adapted from Eikebrokk et al. [2])	Eikebrokk et al. [2]
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 [19])	Davenport [19]
Culture	The organizational readiness to accept and participate in a modeling initiative. (Based on Sedera et al. [24])	Sedera et al. [24]

Table 3. Enterprise modeling practice; Context; Project participant characteristics

Category	Definition	Motivation/Sources
Modeling expertise	The experiences of the project participants in terms of conceptual modeling in general. (Adapted from Sedera [24])	Sedera et al. [24], RAE [28]

Table 4. Enterprise modeling practice; Context; Project-specific characteristics Category Definition Motivation

Category	Definition	Motivation/Sources
Purpose	The purpose of the ICT-enabled process change project	Pilot study of corporate merger
ICT-based future solution	Mean to enable process change. (Based on Davenport [19])	Davenport [19]
Systems development methodology	A standard process followed in an organization to conduct all the steps necessary to analyze, design, implement and maintain information systems [29].	Pilot study of corporate merger
Project management	A controlled process of initiating, planning, executing and closing down a project [29].	Sedera et al. [24]
Resources	Available time, money and people to initiate, plan, execute and close down a project [29].	Pilot study of corporate merger

Table 5. Enterprise modeling practice; Outcome

Category	Definition	Motivation/Sources
The ability to act	Knowledge; ones capacity to set something in motion. Nico Stehr [30]	Henderson [12, page xiii]
Actual process change[1]	The effect of EM on processes. (Adapted from Eikebrokk et al.[3])	Miller and Berger [10] and Vernadat [15]
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 [19])	Eikebrokk et al. [3]
Eventual process maturity	Changes in an organizations capability for process management and operation, including available competence and current practice after the modeling process. (Based on the PMP study [2,21,3]	Eikebrokk et al. [3]
Eventual modeling maturity	Changes in an organizations capability for EM including available competence and current practice after the modeling process. (Adapted from Eikebrokk[2])	Eikebrokk et al. [3]

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 table 5. These sub-categories are mainly linked to the PMP model revised. Concerning the term "The ability to act" it is chosen after being inspired by Nico Stehr [30]. In itself the term points to one of the most important reasons for making enterprise models in the first place.

4   Discussion

The EMP study is initiated to supplement the PMP study looking into model-supported process-change practice. Based on this it seems sensible to let the EMP model build extensively on the PMP model, concerning categories, definitions and motivations, thereby making findings from the two studies comparable. At the same time there are fundamental differences concerning the model build-up and scope of modeling practice research between the PMP and the EMP study.

First of all, the PMP study focuses on process modeling in process change. The EMP study has a wider perspective; looking into the making of enterprise models in general in conjunction with process change enabled by ICT. This broader scope is the result of a specific interest in ICT projects and why they fail. It is not enough to just look into the alteration of job practices when involved in ICT projects; it is important to have a holistic view of business and the processes concerned if the ICT system is to achieve the intended outcome [28]. 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, thereby widen the scope of the model. This especially relates to project-specific characteristics, but other sub-categories can also be found, for example technological maturity in organizational characteristics.

The EMP study is in addition focused on gaining information from different stakeholders involved in the same projects, for example in projects related to supply chain management (SCM); where ICT impacts on the interrelationship between flows of goods and flows of information, as well as interrelationships between different business units.

Whereas 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.

While 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 weakly present or even completely omitted. As seen from the corporate merger case these instances might also reveal interesting relationships.

In general one can say that the scope of further work on EM in ICT-enabled process change directs the EMP research project to focus on potentially complex change processes, with a high degree of organizational impact, cross functional and cross organizational implications and involvement. Persson [31] e.g. emphasizes a wide array of situational factors influencing the quality of enterprise models that moderate the final outcome of an EM process.

5   Concluding Remarks and Further Work

The overall research question for this EMP study is: "How is enterprise modeling used and how can it be used as a technique for IT enabled process change in Norwegian West Coast enterprises?"

The EMP research model constitutes a wide array of propositions/hypotheses concerning EM practice, thereby evoking various directions of inquiry. Examples of relevant questions that can be drawn from the model are:

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

Having developed a reseach model, I will now turn to current practice in companies on the west coast of Norway, focusing on what is modeled and why, when and how modeling is done during the ICT-enabled process change project. Herein it is interesting to see to what extent complexity and uncertainty associated with model-making in general influence to what extent enterprise models are used and where they are used within ICT -enabled process change.

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