Exploring Process-Modelling Practice: Towards a Conceptual Model

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Abstract

Despite the importance of process modelling for business process management and related tasks, there are few theories and empirical studies of process-modelling practice available that can serve as the basis for understanding and improving this important practice. To contribute to the development of better theory, this paper proposes a model of process modelling practice, focussing on the relations between process modelling purpose, process modelling process, model artefact, process modelling outcome as well as initial and eventual modelling and process maturity. The proposed model is based on the existing literature and validated in a study of 34 Norwegian process-modelling projects. Results from a combined qualitative and quantitative analysis of the empirical data indicate that the modelling process is clearly related to process-modelling outcome. Surprisingly, we were not able to relate the model artefact to any main category.

1. Background

Despite the importance of process modelling (e.g., [1,2]) for business process management (BPM) and related tasks [3,4,5], there are few theories available that can serve as the basis for understanding and improving this important activity. There are few empirical studies of process-modelling practice in general.

The aim of our research project is to explore and describe determinants of successful process-modelling practice. A conceptual model of the practice modelling practice is therefore necessary. The purpose of this paper is to develop this conceptual model of process-modelling practice, focusing on the relations between process modelling purpose, process modelling process, model artefact and process modelling outcome. We first develop an a priori conceptual model based on a literature review. We then validate this model with data from process-modelling practice in 34 Norwegian enterprises.

The following section presents existing theory of process change along with our proposed research model and its operationalisation. We then present our research method and our results. We proceed to discuss our findings with focus on implications for further extensive studies, before we conclude the paper and offer paths for further work.

2. Theory and process modelling practice model

Despite large academic and industrial interest in the various variants of process modelling for process change, there are relatively few empirical studies of model-supported process change. Iden [6] interviews Norwegian BPR-consultants, finding that they are surprisingly unacquainted with available process-modelling techniques and tools. Kueng and Kawalek [7] interview participants in process modelling projects, reporting that process models are considered very useful for facilitating communication between users and IT experts. The Process Modelling Success Model [8,9,10] distinguishes between project-specific and modelling-related determinants of process-modelling success [10]. Although the primary focus is to develop and validate the success model through case studies, they also report preliminary results. One such result is that project-specific factors may be relatively more important than modelling- related factors when it comes to success in this area [10, p. 494]. Dalberg, Jensen & Krogstie [11] studies how enterprise modelling – and, specifically, process modelling – is used in different parts of a Norwegian engineering company. They describe when and for what modelling is used, e.g., for process development, software development and quality systems. They also describe expected and experienced types of value of the modelling processes and model artefacts, pointing to typical challenges posed and opportunities presented. In addition we reviewed the potential contributions from more general theories, such as the capability maturity model [12], the IS success model [13, 14] and the technology acceptance model [15].

We discussed and synthesized the contributions from the above theory and empirical findings. This process led to a first a piori version of a *process-modelling practice* (PMP) model (figure 1). The two central variables are Modelling process (MP) and Model artefact (MA) reflecting the activity-artefact dichotomy emphasised by several researchers and traditions, such as [16] and in Activity Theory [17, 18]. Dahlberg et al's central distinction between modelling and models also corroborates these two central categories in our model. As no developed instruments existed for either category, we selected a set of candidate issues from the literature. Following theories that emphasize the intentionality of human activity [e.g. 17], we also introduced a Purpose (P1) category that referred to the anticipated outcomes that are intended by process modelling. This category was in part open to allow for purposes not described in the literature. In part it was also structured according to the activity-artefact dichotomy, dealing explicitly with the intended artefacts produced and the intended effects of process modelling on processes. As the dependent variable, we similarly introduced an Outcome (O2) category that referred to the result of process modelling, again. This category was subdivided into attainment of purpose - an evaluation relative to the stated purpose for each project - and the actual effect of process modelling on processes.

Finally, the model takes organisational maturity into account, inspired by the capability maturity model [12]. Again following the activity-artefact dichotomy, the model takes account of both process and modelling maturity, using questions inspired by the five levels of the original CMM. Including both initial and eventual maturities in the model makes it possible to take account of organisational learning - changes in process or modelling maturity - that may result from the process change project. All the main categories in the model were given clear, explicit definitions.

The arrows in Figure 1 indicate proposed relationships between the main categories. We expect particular types of modelling purpose (P1), along with an organisation's initial process and modelling maturity (PM1 and MM1), to be associated with particular types of modelling processes (MP). We also expect particular types of modelling processes to produce and use particular types of model artefacts (MA). Together, we expect particular types of modelling processes and model artefacts to be associated with particular outcomes (O2) and with an organisation's eventual process and modelling maturity (PM2 and MM2). We have used the term “category” about the elements in the research model because of the combined research approach. For a purely quantitative study, “variable” might have been more appropriate term. This also explains why we chose a relatively rich research model, with as many as 8 main categories. For a purely quantitative study, a simpler model, focussing on fewer variables, might have been more appropriate, and the PMP model will have to be simplified to support future extensive studies..

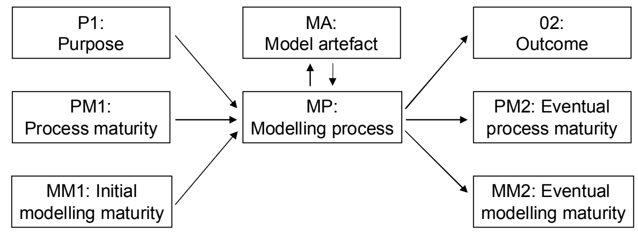

Figure 1: The process-modelling practice model.

The two central categories *Modelling Process* and *Model Artefact* were systematically compared with the relevant dimensions of the Process Model Success Model and supplemented with ideas from the IS Success Model and TAM adopted to process modelling. The *Purpose* and *Outcome* categories were additionally informed by Dalberg, Jensen & Krogstie's [11] process model value model. When defining the *Outcome* category, we focussed particularly on adopting a critical and objective stance, not implicitly assuming that all process change is really improvement for everyone involved and, therefore, not relying too heavily on subjective criteria. The remaining four *maturity* categories, were all based on the Capability Maturity Model, assuming that *process maturity* and *modelling maturity*, although related, could be assessed separately.

Sedera et al's [8, 9, 10] Process Modelling Success Model was an important input to the formulation of our model. Our research model differs from the success model in the following ways: It emphasises the maturity/capability perspective, including as analysis categories both initial and eventual maturity with respect to processes and to modelling. Our model is also more wide-scoped, investigating outcomes as opposed to success. To the extent possible, we emphasise objective measures as opposed to subjective measures. Our research model also includes process model artefacts as a main category. The two models should have good potential to complement one another both in theory and use.

Dalberg et al's [11] mentioning of three main purposes of enterprise and process modelling, i.e., quality systems, process development and software development match our two clusters; process description and process change with or without ICT development. Their distinction between modelling process and model artefact also matches the two central categories in our model. Finally, the different types of process-modelling value identified in [11] can be used to elaborate the outcome category in our model.

3. Method

A semi-structured interview guide was formulated based on our a priori model and improved through a series of 8 pilot interviews. The final guide comprised 26 open-ended questions and was used in 34 interviews. We chose informants from enterprises we knew or assumed had recently undertaken model-based process-change projects. All the interviews were from different process-change projects, but six of them were from different divisions within the same two (larger) enterprises. A typical interview lasted from 45 to 60 minutes.

All interviews were summarised and preliminarily coded in tables. Codes were constructed iteratively and primarily bottom-up, but they were also influenced by the answer alternatives given in the interview guide. A preliminary qualitative analysis was performed by manual inspection based on a subset of the coded questions. Experiences from the preliminary coding and analysis were used to select a final set of 13 questions to use in the most structured part of the data analysis. The experiences were also used to establish a final set of coding rules for each selected question, and to identify subcategories for the main categories, as shown in Table 1. For example, the questions concerning the model artefact (MA) category were divided into subcategories Modelling style (MA.1), Process characteristics modelled (MA.2) and Primary modelling tool (MA.3). The purpose of identifying subcategories was to facilitate both more precise analysis and discussion and discovery of more fine grained patterns in the data.

All the interviews were then re-coded independently by two investigators and inconsistencies sorted out through discussion between the coders. A quantitative analysis was carried out using SPSS, in order to identify significant correlations in the data. A qualitative analysis was carried out using manual inspection and pattern matching using a spreadsheet to complement the quantitative analysis, and to look for additional patterns. We also conducted an open qualitative analysis of the interview summaries.

Before the quantitative analysis, quantitative indices were constructed for each category and subcategory. The categories were converted into variables ranging from "high" (1.0) to "low" (0.0). We took care not to assume that high rank necessarily means "better" rank. Instead, high rank is associated with "more elaborate", "more ambitious" and "more complex" approaches, whereas low rank is associated with "plain" and "simple" approaches. The indices were thus constructed so that a high rank on purpose reflects that ambitions were to change rather than just describe and that new ICT-solutions were foreseen. A high rank on initial process maturity reflects that before the project processes were explicitly described, ownership is effective and the processes are continuously managed.

Table 1: Categories and subcategories used in the coding and analysis.

P1 - Purpose: P1_1 Planned deliverables, P1_2 Intended outcome, P1_3 Modelling purpose
PM1 - Process maturity: PM1_1 Process maturity
MM1 - Modelling maturity: MM1_1 Modelling framework, MM1_2 Modelling competence
MP - Modelling process: MP_1 Management support, MP_2 Modelling framework, MP_3 Participants, MP_4 Individual modelling or workshop, MP_5 Participation and involvement, MP_6 Resistance, MP_7 Modeller, MP_8 Models drawn, MP_9 IT-based future solutions
MA - Model artefact: MA_1 Modelling style, MA_2 Process characteristics modelled, MA_3 Primary modelling tool
O2 - Outcome: O2_1 Attainment of purpose, O2_2 Effect on processes, O2_3 Use of models
PM2 - Process maturity: PM2_1 Process maturity
MM2 - Modelling maturity: MM2_1 Modelling framework, MM2_2 Modelling competence

A high rank on initial modelling maturity reflects that before the project enterprise modelling frameworks were in place and modelling competence was high. A high rank on modelling process reflects that management was involved, participation was broad, modelling was done cooperatively, there was little resistance and several techniques were used in parallel. A high rank on model artefact reflects that many process aspects were modelled and a dedicated tool was used. A high rank on outcome reflects that the project purposes were achieved, that modelled processes were actually changed and that the process models were used after the project. A high rank on eventual process maturity reflects that after the project processes are explicitly described, ownership is effective and the processes are continuously managed. Finally, a high rank on eventual modelling maturity reflects that after the project enterprise modelling frameworks are in place and modelling competence is high.

We chose Spearman's rho correlation coefficient – instead of the more common Person-r coefficient – because our data in general were measured at the ordinal level.

4. Results

This section presents our results from the combined qualitative and quantitative analysis. The analysis used the 8 main categories of the research model as main variables, focusing on the proposed relationships. The purpose is to preliminarily validate the model to pave the way for further studies. An inspection of graphical distributions shows that high-outcome projects tend to have highly complex modelling processes, whereas middle- and low-outcome projects follow simpler modelling processes (Fig 2a). We also find that in our sample high-outcome projects use more complex model artefacts than middle- and low-outcome projects, but the pattern here is less clear.

The analysis confirms that outcome is significantly correlated with modelling process (MP, rs=.523, p=.015, n=21), but not with model artefact or initial maturity levels. Among the subcategories of modelling process, management support (MP_1, rs=.429, p=.023, n=28) and participation and involvement (MP_5, rs=.450, p=.027, n=24) were significantly correlated with outcome. In contrast, none of the subcategories of model artefact correlated significantly with outcome. The relation between modelling process and outcome is as expected. Here and elsewhere, management support (MP_1), participation and involvement (MP_5) stand out as central aspects of modelling processes. It is more surprising that model artefact and outcome are not related in this study, not even at the subcategory-level.

Outcome is also significantly correlated with eventual modelling maturity (MM2, rs=.530, p=.005, n=27). The correlation with eventual process maturity (PM2) is (rs=.306, p=.120, n=27). Hence, high outcome is associated with high eventual maturity both on the process and modelling side, as can be expected.

Eventual process maturity is significantly correlated with eventual modelling maturity (rs=.388, p=.031, n=31) and with individual or workshop modelling (MP_4, rs=.421, p=.017, n=32), a subcategory of modelling process. In addition to outcome and eventual process maturity, eventual modelling maturity is significantly correlated with initial modelling maturity (MM1, rs=.454, p=.012, n=30).

Of the nine subcategories of modelling process, two are significantly correlated with outcome: management support (MP_1, rs=.429, p=.023, n=28) and participation and involvement (MP_5, rs=.450, p=.027, n=24). Modelling framework (MP_2) is significantly correlated with model artefact (rs=.487, p=.022, n=22). Resistance (MP_6) is also significantly correlated with model artefact, but this time negatively (rs=–.468, p=.032, n=21). An inspection of the graphical output shows that, among the questions posed about the modelling process, strong management support (Fig. 2b), use of external consultancy, process training as part of the project and focus on ICT-based future solutions are more common in high-outcome projects. To-be models are more common in high-outcome projects, whereas only using as-is modelling is typical of low-outcome projects.

Participation and involvement is significantly correlated with both management support (rs=.501, p=.011, n=25), with participants (rs=.453, p=.020, n=26) and with modelling (rs=.413, p=.036, n=26). Along with ICT use (MP_9), these are the five significantly correlated components of overall modelling process, and they

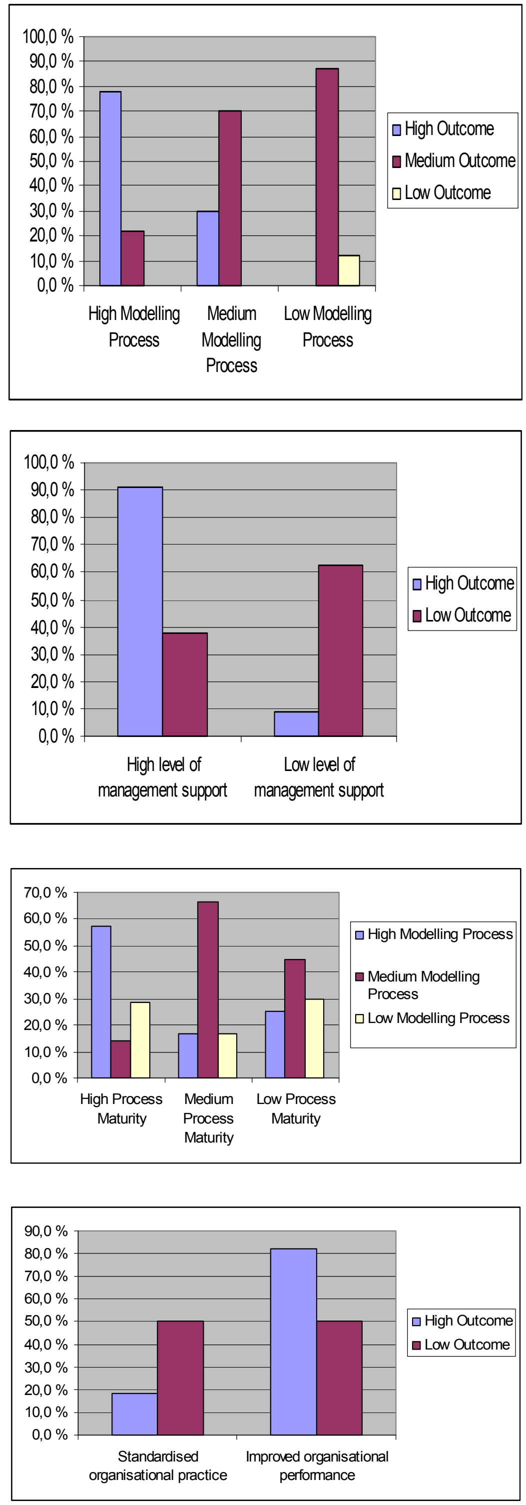

Figure 2: Results from the qualitative analysis: (a) modelling process and outcome, (b) management support and outcome, (c) initial process maturity and modelling process and (d) types of project purpose and outcome.

broadly match the corresponding qualitative results. Again, we see that management support (MP_1) and participants (but this time MP_3) are central aspects of modelling processes.

We did not find significant correlations between model artefact and the other main categories. None of the subcategories of model artefact are significantly correlated with another main category either. Likewise, initial process maturity were not significantly correlated with any of other the main categories, nor with any of their subcategories. However, figure 2c indicates a weak pattern between high initial maturities and complex modelling processes.

Purpose is not significantly correlated with any other main category, although it is significantly correlated with the subcategory ICT use (MP_9, rs=.490, p=.003, n=34). The importance of the purpose category may instead be to facilitate narrower analysis or different types of process-change process. Cluster analysis (two-step, log-likelihood, Schwarz) of the coded answers in the purpose category reveals that our 34 projects fall into two clearly distinct clusters:

16 projects fall into the process description cluster. These projects focus on describing existing processes for standardisation and quality-control purposes. They do not attempt to change existing processes radically. The results may be documented in a new or improved on-line quality system or similar.

18 projects fall into the process improvement cluster. These projects focus on improving the efficiency and effectiveness of existing processes. They often attempt to change existing processes radically. The results may be documented in an on-line quality system or similar. In addition, 10 of the projects in this cluster have requirements for IS design as one of its purposes.

This partition is broadly supported by alternative clustering algorithms (two-step, log-likelihood, Akaike and hierarchical clustering). Qualitative analysis indicates that high project outcome is more common in the process improvement that in the process description cluster, as could be expected and as shown in figure 2d. Separate quantitative analyses of the primary categories for the two clusters only show significant correlations for the two eventual maturity variables, although not many significant correlations were to be expected with so few data points.

5. Discussion

5.1 Implications for practice

The purpose of this project was to validate our conceptual model. However, we can also identify several issues that are relevant for practice. First, the modelling process is an important factor for project outcome. We did not find any systematic patterns between model artefact and outcome, not even at the subcategory level. Therefore, issues relating to modelling *process* seem to be more important than issues relating to modelling *artefact*. Organisations undertaking business process modelling projects should therefore pay more attention to the modelling processes than to the modelling artefacts.

Second, complexity of modelling processes are associated with high outcome projects. This may be an indication that ambitious projects take into account the complex nature of organisational processes.

Third, we find that participation and involvement were significantly correlated with outcome. Thus, organisations aiming for high project outcomes should consider a high level of employee participation.

5.2 Validation of the conceptual model

The validation showed that, as a research model, the PMP model does not describe the categories and relations well enough and needs to be developed further. Our results suggest several propositions for further studies. A relation between modelling process and outcome was indicated. In addition, although not proposed, our sample showed relations between outcome and eventual process and modelling maturity. Additional relations involving subcategories were also identified. Interestingly, our sample has a significant relation between the *participation and involvement* subcategory and outcome. This should be an important topic for further inquiry. It is also interesting that our resistance variable is reversed relative to the model artefact. This is an indication that a certain degree of resistance could be a sign of maturity in model-based process-change projects. This should be investigated further.

Surprisingly, model artefact did not turn out to be significantly correlated with any other categories. The qualitative analysis should inspect this category carefully, and further work should carefully assess the associated questions and coding. Multivariate analysis should be used to investigate interactions between model artefact and other categories, such as project purpose and initial process and modelling maturity. The questions and coding associated with initial maturity also need to be carefully reconsidered.

Purpose was also related to few other categories in the model. This is less surprising, because purpose should perhaps instead be used to distinguish different types of projects that should be analysed separately. Our cluster analysis of the coded purposes identified two main groups, one group of process-documentation projects and another of process-change projects. An initial attempt at separate analyses of the two groups failed to give significant results, perhaps because the numbers of projects in each group was too low. The groups should be investigated further in the qualitative analysis and in further extensive studies. Figure 3 illustrates the findings in the conceptual model.

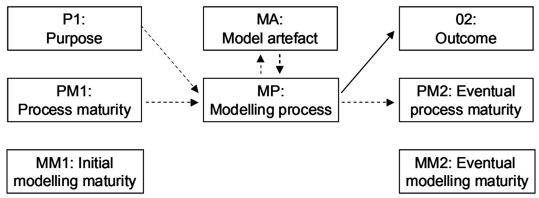

Figure 3: Figure showing significant correlation (solid line) and weak patterns (dashed line)

5.3 Limitations

The results suffer from several limitations that are common in exploratory research. It is based on relatively few projects, and the enterprises and their projects do not constitute a representative sample. We also only interviewed one person involved in each project, typically a project leader, facilitator or sponsor, which may have presented a slightly positive view of both process modelling and of process change. Yet we find the selection of projects and informants sufficient for a pilot study like this. All the results we have presented have been statistically significant despite the low number of projects. And although the projects did not constitute a statistically representative sample, we deliberately sought to include a broad variety of enterprises and projects, which should make our findings more robust. Further work should investigate a larger and representative sample, both in Norway and internationally. The international studies should aim to generalise the model internationally while keeping it sensitive to national culture differences. Further work also needs to collect information from a broader range of project participants.

The main categories/variables were established before data collection, and relationships between them were proposed through the research model. This part of the study therefore follows a conventional hypothesis-testing approach. However, we also looked for other significant correlations between main variables and between main variables and variables that describe subcategories, and the subcategories were themselves constructed by inspection of the collected data. This part of the study therefore follows a theory construction approach, and the results from this part are susceptible to the usual problem of spurious "shotgun" correlations [1]. They are therefore to be used only as candidate propositions for further research.

Finally, despite a series of 8 pilot interviews, some of our questions turned out to be unusable in the quantitative analysis. Some of these questions went into specific details of process modelling, too detailed to be included in the analysis. Such questions did however provide more insight into the individual cases, and more in-depth understanding of management support, participation and resistance in these companies.

Further work should carefully review the questions and answer alternatives, taking into account the subcategories that have emerged.

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