Factors Affecting the Sustained Use of Process Models

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Abstract. The documentation of business processes via modelling notations is a well-accepted and widespread practice. While a given process model is created in a specific project and sometimes for a specific purpose, it is generally preserved so that it can be used subsequently, beyond the context where it was created. In this setting, the aim of the paper at hand is to uncover factors that affect the sustained use of process models in an organization. First, the paper outlines an a priori model of sustained process model use derived from existing factor models of business process modelling success and knowledge reuse. This a priori model is packaged as an assessment instrument and applied to four organizations from different domains. Based on these case studies, we identify a subset of factors and relationships that explain differences in the observed sustained use of process models across the organizations in question.

Keywords: success factors, process model use, process modelling

1 Introduction

Business process management (BPM) is a central component of information and operations management practices in modern organizations. A common practice within BPM projects or programs is to capture the business processes of an organization in the form of business process models. Process models serve manifold purposes, including preserving and communicating knowledge as well as analyzing, redesigning and automating processes for the purpose of continuous business improvement [1].

Process models are generally created for a specific goal [2]. For example, a model of an order-to-cash process might be created in the context of the deployment of a new enterprise resource management system in an organization. However, said model can be subsequently re-used for other purposes such as training of new staff members or continuous process improvement. If process models are to serve as a unifying vehicle for managing business processes, it is desirable that they are reused over a sustained period of time, past the specific initiative or project where they were created.

Various studies have elucidated and analysed the determinants of knowledge sharing and reuse in organizations [3,4]. In comparison, the reuse of process models – as an integral component of an organization's knowledge base – has received less attention. Some studies have considered the question of process model use and reuse, but only in the context of specific projects, rather than sustained use over time.

In this setting, this paper studies the question of *what factors determine whether process models are used in a sustained manner or only for the purposes they were*

initially created? To address this question, we follow a two-phase research approach. In the first phase, we analyze the literature on success, impact and reuse factors of process models and more broadly knowledge reuse. Drawing upon previous studies, we build an a priori factor model of sustained process model use. In the second phase, we conduct case studies in four organizations. In these case studies, we assess the current state of each organization with respect to the identified factors on the one hand, and their level of sustained process model use on the other hand. Based on data collected during the case studies, we establish possible relations between the identified factors and the observed process model use in the organizations under scrutiny.

The rest of the paper is structured as follows: Section 2 provides an overview of related literature, putting forward existing models that may be used to explain process model use or reuse. Section 3 presents the a priori model of sustained process model use. Section 4 discusses the case studies and associated findings. Finally, Section 5 concludes and sketches directions for future work.

2 Theoretical Background

Process models are generally created and initially used in the context of specific BPM initiatives or projects with certain purposes in mind. Process models can be created, for example, in the context of a process improvement project [5] or within the scope of a software integration project [6], and used for the purposes of the project where they are created. Once created, a process model or collection thereof can be reused for different purposes outside the scope and timeframe of the project. For example, a process model created in the context of a software integration project could be used later in the context of a process analysis and improvement project or vice versa. Such repeated use is called 'reuse' – a repeated use of the process model for different purposes or tasks than initially envisaged [7]. Process model reuse can occur in a one-off manner, or can recur over time.

Sustained use – called 'continued use' by some authors [8] – occurs when a process model or collection thereof is reused on a regular basis over and over again past the project in which they were initially created and for different purposes or tasks. This regularity makes that the model becomes part of the general knowledge of the organization, or of a subset thereof. Thus, the question of what are the factors that determine sustained process model use is intertwined with two other questions, namely: (i) what determines the success of projects or initiatives where a collection of process models is created and initially used; and (ii) what determines the fact that a given process model or a collection of process models is re-used in a sustained manner past the project or the initiative where they were initially created.

In literature review, we focused on papers on knowledge and more specifically, process model reuse in organizations. Additionally, papers on process modelling as an essential presumption of process model reuse were linked into our review.

2.1 Process Modelling Project Assessment

Process modelling project success factors have been studied by Bandara et al. [9] who propose a model of critical success factors of individual process modelling projects. The focus is on project success and the initial use of the process model during the project. This model is composed of eight success factors and five success measures. The success factors include project-specific factors and modelling-related factors. Examples of success factors are 'Modelling Expertise' and 'Modelling Tool'. The purpose of success measures, on the other hand, is to assess the initial use of process models and the impact that such initial use creates in an organization. Success measures in Bandara et al.'s model include, for example, 'Model Quality' and 'Process Impact'. The proposed model summarizes previous studies on process modelling success factors and has been tested in practice.

At a more upstream level, Eikebrokk et al. [10] have proposed a theoretical model of determinants of business process modelling in organizations. In other words, they study the question of why certain organizations have practiced modelling over long periods of time, whereas others have not. In our study, however, we focus on a complementary question, namely: given an organization where process modelling has been practiced, what determines the fact that some process models get to be used on a sustained basis while others are only used in projects where the models are created.

Another related study is the process modelling impact framework of Bernhard and Recker [11]. This study synthesizes different studies on process model use and proposes a model to explain a perceived or actual impact of process modelling along an organization's objectives. This model highlights seven factors related to process modelling initiatives and process model use. However, the model in question is not intended to assess process model use per se, but rather the organizational impact that process model use creates.

2.2 Knowledge and Process Model Reuse

Determinants of knowledge reuse in organizations have been studied by Watson and Hewett [12], who proposed a success factors model (eight factors) influencing knowledge reuse and user contribution in an organization. Examples of success factors in their model are 'Training in Knowledge Reuse' and 'Value of Knowledge'.

Many researchers have tested different factors based on DeLone and McLean success model [13]. This model focuses on the information system and knowledge usage in an organization and on influences between different factor groups. Success related to different quality dimensions (information, system, service) has been studied by Jennex and Olfman [8]. Success factors tested in their model (nine factors) are, for example, 'Linkage (of the information)' and 'Management Support'. Jennex and Olfman [14] provide a comparative review and synthesis of determinants of knowledge management success, as well as a detailed comparative analysis of four success factor models in this area. Their synthesis puts forward a number of organizational, tool and user-related factors that we take as input for constructing our a priori model.

Success factors related to process model reuse have been studied by Nolte et al. [7] who propose a set of factors that determine process model reuse after the process modelling project. Their model consists of 16 factors (arranged into five categories) including 'Software Ease of Use' and 'Modelling Expertise'.

From the angle of information system use, factors that influence sustained use have been researched by Recker [15] in his study where factors influencing the use of software are under scrutiny. In the study, important factors influencing the use of software are, for example, 'Perceived Ease of Use' and 'Perceived Usefulness'.

An important component highlighted in aforementioned articles is the quality of information base, first and foremost in the context of a process model [7] or of a knowledge base [12], but also more widely on various aspects of tools and organization [14]. The issue of quality has been separately addressed in article [16], where specific reference is made to quality parameters in the context of different important objects (such as the modeller, tool, aim of modelling); it is also analysed how different aspects of quality are interrelated.

Quality of process models [17] is more narrowly treated in articles [18,19] where the reuse of process models from the angle of the end user is analysed – which parameters of process diagrams facilitate better understanding of information by the reader of the process model and reduce the number of mistakes in the creation of models. Here, the parameters of model quality metrics are, for example, 'Complexity' and 'Size'. We did not involve more detailed quality metrics (variables) associated with the process model. Rather, the focus was on more gen-eral factors that the organization can support and influence through different activities. Thus, these topics have been incorporated into our model through more general factors such as 'Ease of Interpretation' (clarity and ease of the model for the end user) and 'Structure' (presentation of complex and extensive information through easily understandable structure) [20].

Process model reuse may occur at different levels of granularity as analysed by Holschke et al. [21]. This latter paper focuses on process model reuse in the context of modelling rather than on the question of continued use of a process model over time.

The reuse of models is an important issue in the context of reference models [22] that bring together important knowledge from a given field and presents it as a complete model. Important aspects in the use of reference models have been examined by Frank [23] who brings out 'Understandability', 'Tools', 'Skills' as significant topics. Reference models are intended for repeated use rather from the angle of development for managers and analysts in shaping the organization or in the creation of new systems. The focus of our study is rather on the wider internal use of process models.

The next section introduces the a priori model of sustained process model use that we will base on models of success factors focused on different phases of BPM.

3 Assessment Framework for Process Model Use

This section introduces the proposed assessment framework for process model use. First, we will provide an overview of the framework and its rationale. Next, we will introduce the success factors. Finally, we are going to introduce an assessment instrument for applying the framework to a specific organization. Definitions of different factors have been provided in the Appendix.

3.1 Overall Structure

The proposed assessment framework is grounded on a life cycle model of a BPM programme [24]. In this model, a BPM programme consists of a number of BPM projects that evolve concurrently (or sequentially), each one following a four phase life cycle: (1) project preparation; (2) project implementation; (3) deployment and initial use of the produced models; (4) post-deployment and sustained use of the models. Moving along the phases of a BPM life cycle, we highlighted the topics and categories in the context of which the factors could be observed.

The project preparation phase is concerned with the identification and scoping of business needs and goals, resource planning, risk analysis, and other project preparation activities [25]. This phase brings the category 'Organization' into our framework.

The project implementation phase includes activities where the modelling team investigates which processes are involved, collects relevant data about these processes, produces the process models, performs corresponding quality checks and discusses the models to relevant stakeholders [26]. Within the modelling phase, focus is on modelling (category 'Modelling') and on the model that is created as a result (category 'Process Model').

The project deployment phase includes the publication of models (category 'Tool') to their intended audience and other activities related to the initial use of the model within the scope of the project. For example, individual models can be used for process analysis, re-design and IT system implementation [6].

The post-deployment phase encompasses activities where the models are used for purposes beyond the scope of the project in which they were produced. This phase includes model maintenance (e.g. corrective or perfective updates from outside the scope of the project), reuse of parts of the model in other process models, and perusal of the model [27]. The post-deployment phase brings into our model the category 'User' – which draws together factors pertaining to the (long-term) users of the model. Activities implemented in previous phases influence the context where the process model is used; the main difference with the previous phases is the shift in emphasis which moves from modelling to everyday use. We define sustained process model use as regular, post-deployment use by multiple stakeholders for different purposes.

3.2 Categorization of Factors

Moving along the life-cycle model, we concentrated different factors from multiple success factor models under the categories given in Chapter 3.1 (the focus of most

articles is on the phase of 1-2 BPM life cycle). In order to avoid overlapping between factors under a category, we followed the orthogonality rule between factors. We kept those factors in the table, which had been brought out in at least two different success factor models. The resulting set of factors is summarized in Table 1.

Table 1. Success factors under different categories.

	Organization			Modelling					Model							Tool		User		
	Management Support	Clear Goals and Purposes	Subjective Norms	Modelling Expertise	Stakeholders Participation	Information Resources	Project Management	Modelling Methodology	Modelling Language	Modelling Tool	Richness	Knowledge Quality	Value of Knowledge	Structure	Ease of Interpretation	Ease of Use	Usefulness	Competence	Motivation	Knowledge Networking
Process Modelling																				
Bandara et al. 2005 [9]	x			x	x	x	x	x	x	x										
Raduescu et al. 2006 [29]	x	x	x	x	x	x	x	x	x	x										
Rittgen 2010 [30]			x		x	x														
Lu and Sadiq 2007 [31]								x	x	x										
Process Model use																				
Nolte et al. 2013 [7]			x									x	x		x	x	x	x	x	x
Rosemannn 2006 [28]		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x
Recker 2006 [15]																x	x			
Mendling et al. 2010 [20]														x	x					
Knowledge Management																				
Jennex and Olfman 2005 [14]	x	x	x	x											x	x			x	x
Jennex and Olfman 2006 [8]	x										x	x				x				
Watson and Hewett 2006 [12]													x	x		x		x		
Yew Wong 2005 [32]	x	x	x													x	x	x	x	x

Next, we will present a summary explanation by categories of factors, following the BPM lifecycle.

To start with, a process model has to be created. Process modelling projects are usually complex and voluminous, thus different authors have highlighted different critical aspects/factors to be emphasized ('Stakeholders Participation', 'Management Support', Information Resources', 'Project Management', 'Modelling Expertise'). Furthermore, technical choices regarding methodology and tools that influence wider use of the model also after the end of the process modelling project, are important as well ('Modelling Methodology', Modelling Language', Modelling Tool').

While creating a process model, it is important to establish a sound information base for analysis and planning. There are two criteria for the user who will be using the model in a sustained manner after the project: usefulness and ease of use.

Usefulness is related, first of all, to the existence of necessary data ('Richness'). Second, data has to reflect real processes ('Knowledge Quality'): (1) during the process modelling project, different facts and relations in the model must reflect real processes; (2) changes in the process have to be reflected in the model after the project (the model has to be updated). Finally, all this information should be valuable to the user ('Value of Knowledge').

The basis for ease of use is, above all, clear and comprehensive structure of the process model. Process models are complicated and thus, a flexible structure (process hierarchy) is extremely important to decompose facts first and find out needed information later ('Structure'). In addition to the general structure, smaller groups and views of information (diagrams, lists of facts) must be well presented to the reader ('Ease of Interpretation').

Proper software tools have to be used to gather information from the process model. First, we summarize technical issues (accessibility, system quality, service quality) into the factor 'Ease of Use' – there should not be any technical obstacles in using software. Functional aspects of the software have been collected under the factor 'Usefulness' – a functionality necessary for browsing process models is provided.

A model of good content and technical quality together with comfortable software create the necessary prerequisites for the user of the process model user – an experienced and motivated employee, interested in gathering information from the process model and ready to contribute feedback for model update. First, competence concerning the process model and tool use is needed ('Competence') - many authors emphasize training and learning under this factor. The user has to be motivated to use knowledge for different purposes (getting new information, verifying facts and relations) in daily operation ('Motivation'). Finally, (positive) experience about sharing information in the organization is necessary ('Knowledge Networking') – first in finding the necessary information, then using it and finally sharing it with colleagues.

Everything described above will be carried out in a specific organization with technical and cultural environment that has developed over the years. Success factors that characterize general attitudes in the organization toward BPM initiatives are under category 'Organization'. The first question in the context of organizations and projects is – why BPM? The answer should be clear and communicated in the organization ('Clear Goals and Purposes'). In parallel, attitudes of different employees toward BPM initiatives and the process model have been reflected ('Subjective Norms'). Success factor 'Management Support' was already mentioned in the context of process modelling project. Management support is the key to success during all phases of a BPM life cycle. For this reason, we have moved the success factor 'Management Support' from the category 'Process Modelling' to the category 'Organization' in the context of our framework.

3.3 Assessment Instrument

Our assessment framework consists of a number of factors, which affect different types of process model usage in different phases of a BPM programme. The proposed factors were derived from different studies highlighted in Section 2 and analysed via the categorization given in Section 3.2.

Each factor is rated with reference to *activities* performed as part of the BPM project and considered by the organization's assessors as supportive of the factor in question. As a result, we cannot get a direct assessment (result) for the factor; rather, we can see which factors have been emphasized in the organization and which have been

influenced. The choice of activities associated to a given factor is left open for assessors. For example, in assessing the factor 'Modelling Expertise', possible activities may include 'in-house development of modeller expertise', 'training of employees in process modelling' or 'outsourcing of modelling expertise'. The factor 'Management Support' could be assessed through activities that reflect positive (or negative) attitudes of management towards a BPM project or programme – for example, 'management participation in the BPM project' and 'mentions and recognition of BPM projects at board meeting(s)'.

Factors could be described (assessed) either through planning or already accomplished activities. If a project has already been implemented, then the real activities that constitute a factor (for example, modelling activities which reflect the 'Modelling Expertise') should be highlighted.

With reference to activities, each factor is rated via five-point Likert scale [33] with following labels:

- -2 – no activity has been undertaken or is planned regarding a factor;
- -1 – activities are planned, but not yet realized regarding a factor;
- 0 – there are activities partially (or fully) realized regarding a factor, but without real influence;
- 1 – activities have been realized regarding a factor with some positive results;
- 2 – activities have been completed regarding a factor and have led to observable results.

Based on the rates of factors, an average for every category (fourth column in Table 2) was calculated. In addition to the assessment concerning the influence of different factors in various BPM phases, we asked the interviewees for their assessments on the importance of factors with the view of positively influencing the continued use of the process model in the organization – participants in interviews ranked the factors under every category (the most important rank = 1).

In order to assess whether process models are used continually, we checked technical user logs. Process model was considered as used in a sustained manner when:

- process model use had continued after the process modelling project (1+ years);
- users group expanded after the project;
- users were using the process model on a regular basis (at least few cases in a month per every user).

Our focus was on the process models with active use over a long period: first initial use during the process modelling project followed by active use over a period of more than one year after the initial production of the model.

Moving along the time axis (BPM phases), we will concentrate on how different factors have been influenced in the organization (as a result, different categories as a whole) and what is the actual final result in view of everyday use. We will collect expert assessments of process managers regarding the influence of each factor from the angle of sustained use on the basis of classifications.

4 Case Studies

We can recall from Section 1 that the overarching question of the study is the following: what are the factors that determine whether process models are used in a sustained manner, or only for the purposes they are initially created? Having proposed a framework for assessing process modelling factors, we have decomposed the research question into following sub-questions:

- which factors of the a priori model are highlighted by organizations as most relevant for sustained use?
- are the grades assigned by process modelling stakeholders in an organization to the different factors in the a priori model in accordance with the actual use of process models after the process modelling project has been finished?

To address these questions, we followed a multi-case-study approach [34]. We determined that the case study method was suitable in our context as it allowed us to collect qualitative insights from practicing experts embedded in organizations where process models have been produced and used. The possibility of gathering such qualitative insights was considered to be important, given that the proposed a priori model – though derived from a synthesis of previous models – is new and not previously validated in practice. For this reason, an exploratory approach was selected to validate our a priori model and investigate raised questions in parallel [35].

Multiple organizations were involved in the study in order to increase reliability and generalizability of the findings. The data collection was based on focused interviews designed to put into evidence concrete activities performed by the organization in support of each factor, as well as influences between factors and sustained model use (or lack thereof).

Below, we will discuss the organizational setting of case studies, the case study protocol employed (including data collection steps) and the findings.

4.1 Case Study Setting

We selected four organizations as case studies from different points along two spectra: public-private; medium-large [36]. The four organizations are:

- Bank of Estonia – a large constitutional public institution that operates under its own statutes and under the law, with a long history and experience with BPM.
- Estonian Telecom – a large private company formed via the merger of two previous telecommunication companies, both with long experience in BPM.
- Estonian Agricultural Registers and Information Board (ARIB) – a medium-size public organization implementing a range of business process-related projects.
- Elisa Estonia – a medium-size branch of a private international telecom service provider with many years of experience with BPM.

The case studies were conducted during 2014-2015. Below, we will present the case study protocol and summarize the findings.

4.2 Case Study Protocol

First, an initial contact was established with a member of the organization in order to present our broad vision of BPM success factor analysis.

Second, an assessment was organized in cooperation with the BPM team of each organization, including the BPM project and process managers. The assessment framework for process model success factors was introduced to the BPM team (~15 min) before the assessment. Next, we covered the success factors following the BPM life cycle, e.g. time line. The data collection was based on the structure of a priori model described in Section 3.2. For each success factor, we drew up a list of activities which had either been carried out or were planned to be carried out, and which characterise or support the given factor. The BPM team was asked to explain the results of these activities and the influence achieved in their organization. Information was recorded in a structured table composed of the following columns: factor; activities related to the factor; results of activities, grade for the factor; comments and ideas. An example of a part of a completed assessment table is presented in Table 2. Columns 'Activities', 'Results' and 'Comment' were filled in during the interview. The interview lasted for about two to three hours. Data collections were conducted in the context of recently implemented BPM projects and in terms of complete BPM programmes with the focus on process models used afterwards. The table filled in during the interview was the basis for the factor assessment after the meeting. We applied the assessment instrument described in Section 3.3. Grades were stored in the fourth column in the table - 'Grade'.

Third, separate meeting for the table and assessment results review were organized with BPM teams of each organization. During the meeting (about one hour) important improvements and details were collected and added into the table (columns 'Activities' and 'Comments'), if needed, the grades of assessment were justified (column 'Grade'). BPM team members ranked the assessed factors by importance in the context of categories, thus giving their evaluation to the importance of factors to influence the reuse of a process model. The first had to be a factor that, in assessor's opinion, has the most significant impact on the reuse of a process model (number 1), and the last had to be a factor with the lowest impact on the reuse of a process model in assessor's opinion.

The fourth meeting (about one or two hours) was aimed at reviewing the actual usage of process models in the organization. For each model referenced in previous meetings, the number of users and frequency of usage of the process model during the process modelling project and after the project was determined. Information was provided by the project manager of the BPM programme, the administrator(s) of the intranet and process modelling repository where models were maintained and published. Based on these data, we classified the process models into those that had undergone sustained use and those that were not used in a sustained manner according to

the definition of sustained use previously introduced. Three to seven people participated in the study from each organization (21 in total).

Table 2. Example of an assessment table filled in during interviews.

Factor	Activities	Results	Grade	Comment	Rank
Modelling Expertise	An outside consultant was used for process modelling. Our people (development department) attended modelling activities and obtained experience concerning process modelling. After the project in-house training was organized.	Excellent expertise in the context of the project. Modelling experience for our modellers.	1	BPM knowledge is sufficient for process model update today, but backup is needed.	1
Stakeholder Participation	Employees did not attend the project. Department managers attended the BPM training organized after the project.	BPM (basic) knowledge for our department managers.	0	More users should be involved in the BPM project in the future.	3
…					

4.3 Findings

Every organization had a diverse know-how of BPM projects and a different perspective of process model usage. Our findings during the interviews and analyses of the BPM programmes of these organizations highlighted factors that affected process model usage in a sustained manner after having completed several BPM projects.

There were diverse experiences concerning process modelling (projects) in every organization that participated in the case study (average of category 'Process Modelling' 0.9). Organizations highlighted mainly the influence of *project modelling activities on process model quality*: "The initial models were too technical and of poor quality, keeping in mind the wider audience." It was underlined in the interviews that quality depends directly on modeller's experience and skills.

Process model quality was the central topic in the context of models used in a sustained manner in organizations (average of category 'Process Model' in the organization higher than 0.5). The structure of the model (factor 'Structure') was highlighted as a key in making technically complicated models suitable for regular users and reaching sustained use after the modelling project: "The only thing we elaborated after the project was the general structure of the model". Every other factor under the category 'Process Model' was already supported and had achieved the necessary level during the process modelling project.

The average grade along the "process modelling tool" was relatively high (category 'Tool' above 1.0). In process modelling phase, software functionality was emphasized as an attribute that fully supports the modeller upon entry and analysis of information; from the perspective of process model users, simplicity both regarding the uses as well as the user interface was underlined first and foremost. Modern BPM tools provide versatile functionality for process modellers and *different types of re-*

ports and views extracted from the process model for consumption by a wide range of users. In all organizations, software used in the project or its outputs were integrated into other systems of the enterprise "after the project, the model was integrated into our knowledge management system".

In our assessment, we gave a high grade to factors under the category 'User' (average 0.4). *Practical experience was especially highlighted*, different trainings and courses were of secondary importance in our interviews: "Our users grow along with BPM projects". Factor 'Competence' was always higher than factor 'Motivation'. Sustained use was achieved with models where the grade of factor 'Motivation' was closer to the grade of factor 'Competence'.

Success factors related to organizations were variable (averages of category 'Organization' between -0.4 and 1.1) – even low grades for factors in the category 'Organization' were not an obstacle for starting to use the process model in a sustained manner in the organization. Success factors (especially 'Top Management Support ') under category 'Organization' were more likely *related to process modelling project*: "Our management decided to start BPM activities in our organization five years ago". Sustained use of process models was rather a bottom-up initiative (especially in organizations where the grade for category 'Organization' was lower) related to BPM team or a small group of people: "Business people participating in the project started to use the model on a regular basis after the project was finished". Organizations where the grade for category 'Organization' was higher emphasized *positive influence on the users* (employees): "The active use of the model by the management set an example to the rest of the members of the organization".

4.4 Limitations and threats to validity

The findings of this research should be construed in the light of typical limitations and threats to validity of a case study research, particularly with regard to low generalizability. To mitigate this threat to validity, we conducted multiple case studies (multi-case-study approach) and supported the findings with observations across the case studies. We also selected case studies from different types of organizations in different domains (public vs. private large vs. small). However, all four case studies were conducted in the same geographical region (Estonia). Also, the findings are based on a relatively small number of business process modelling projects and process models (8 projects in total). The involvement of more organizations, projects and process models into the research would increase the validity of results.

Another threat to validity comes from the adoption of an a priori model that scoped the set of factors considered in the case studies. This threat is mitigated however by the fact that the a priori model has been built on the basis of success factor models created and validated by different researchers in previous work.

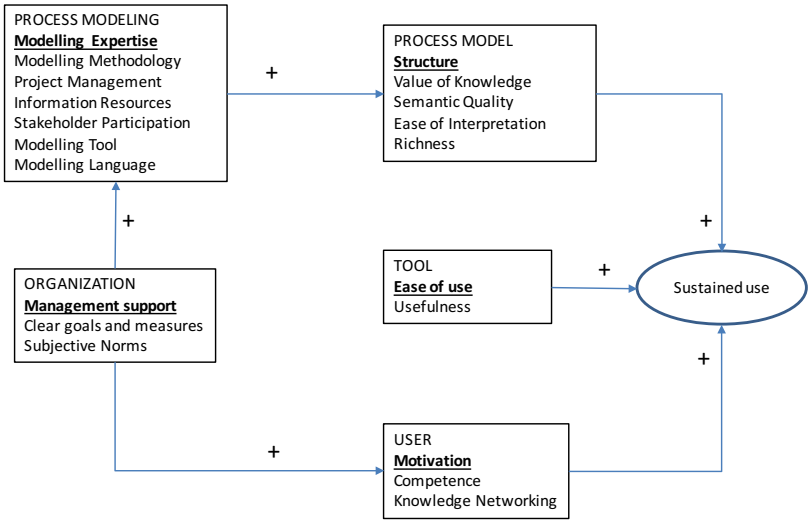
The data collected during the case studies was mainly qualitative. The only quantitative data was related to use of process models (number of "model use" events and their time). These quantitative data were gathered to the extent required to determine if a given process model was used in a sustained manner or not. A more in-depth

quantitative analysis of actual use of process models could increase the reliability of the results and reveal more details about sustained use of process models.

5 Conclusion

We have proposed a model to explain the sustained use of process models and validated it on four case studies. The findings of the study are summarized in Figure 1. The boxes correspond to the categories of factors presented in Table 1, while arrows indicate the identified influences between factors in a category and sustained use of process models. The statements in case studies supporting each influence arrow can be found in Section 4.3 (cf. statements highlighted in italics). Factors have been ranked under each group based on the participants' assessment collected in the third meeting (cf. last column of Table 2: "Rank").

Fig.1. Direct influences between different factor groups



A notable observation highlighted by case studies is that the characteristics of process models influence their sustained use. One factor in particular that was highlighted as contributing to sustained use was the 'Structure' of the process model. The importance of structure is also confirmed by study [37,38], where the topic of process hierarchy came up through studying the quality of a process model and the influence it exerted on process management in an organization. Also, structure is an essential component of the quality of the model and comprehensibility to the user [20].

In the 'User' category, 'Motivation' appears to be a key factor in the context of our study. Significance of motivation is also outlined in the study by Bhatt [39], where the topic was approached more widely from the angle of organizational behaviour.

Indication of support from the management was not surprising, as the launch of large projects needs such support [14]. In the context of our study, indication of the impact of management on users through positive example was found to be important.

In our future work, we plan to conduct more detailed studies within mature organizations with a longer history of process modelling and more detailed (quantitative) data of process model use over time. This would enable us to study the sustained use of process models longitudinally as well as cross-sectionally across different areas of an organization. We also plan to expand the scope of organizations covered by the study to cover a wider geographical context.

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References

1. Davies, I., Green, P., Rosemann, M., Indulska, M., Gallo, S.: How do practitioners use conceptual modeling in practice? Data & Knowledge Eng. 2006, vol. 58, pp. 358-380.
2. Indulska, M., Green, P., Recker, J., Rosemann, M.: Business process modeling: Perceived benefits. In Conceptual Modeling-ER 2009, pp. 458-471. Springer (2009)
3. Dalkir, K.: Knowledge management in theory and practice. Routledge (2013)
4. Markovic, I., Pereira, A.C.: Towards a formal framework for reuse in business process modeling. In Business Process Management Workshops 2007, pp. 484-495. Springer (2007)
5. Jeston, J., Nelis, J.: Business process management. Routledge (2014)
6. Rosemann, M., vom Brocke, J.: The six core elements of business process management. InHandbook on Business Process Management 1, pp. 105-122. Springer (2015)
7. Nolte, A., Bernhard, E., Recker, J.: " You've modelled and now what?"-exploring determinants of process model re-use. In 24th Australasian Conference on Information Systems 2013, pp. 1-11. RMIT University (2013)
8. Jennex, M.E., Olfman, L.: A Model of Knowledge Management Success. International Journal of Knowledge Management 2006, vol. 2, pp. 51-68.
9. Bandara, W., Gable, G.G., Rosemann, M.: Factors and measures of business process modelling: model building through a multiple case study. European Journal of Information Systems 2005, vol. 14, pp. 347-60.
10. Eikebrokk, T.R., Iden, J., Olsen, D.H., Opdahl, A.L.: Understanding the determinants of business process modelling in organisations. Business Process Management Journal 2011, vol. 17, pp. 639-62.
11. Bernhard, E., Recker, J.C.: Preliminary insights from a multiple case study on process modelling impact. In Australasian Conference on Information Systems 2012, pp. 1-11.
12. Watson, S., Hewett, K.: A Multi-Theoretical Model of Knowledge Transfer in Organizations: Determinants of Knowledge Contribution and Knowledge Reuse. Journal of management studies 2006, vol. 43, pp. 141-73.
13. Delone, W.H., McLean, E.R.: The DeLone and McLean model of information systems success: a ten-year update. Journal of management information systems 2003, vol. 19, pp. 9-30.
14. Jennex, M.E., Olfman, L.: Assessing Knowledge Management Systems. International Journal of Knowledge Management 2005, vol. 1, pp. 33-49.
15. Recker, Jan C.: Reasoning about discontinuance of information system use. Journal of Information Technology Theory and Application 2016 vol.17.1, pp. 41-66.
16. Krogstie, J., Sindre, G., Jørgensen, H.: Process models representing knowledge for action: a revised quality framework. European Journal of Information Systems 2006, vol. 15, pp. 91-102.

17. Vanderfeesten, I., Cardoso, J., Mendling, J., Reijers, H.A., van der Aalst, W.M.: Quality metrics for business process models. BPM and Workflow handbook. Pp. 179-190. (2007)
18. Sánchez-González, L., García, F., Mendling, J., Ruiz, F., Piattini, M.: Prediction of business process model quality based on structural metrics. In Conceptual Modeling, ER 2010, pp. 458-463. Springer (2010)
19. Mendling, J., Neumann, G., van der Aalst, W.: On the correlation between process model metrics and errors. 26th International Conference on Conceptual Modeling 2007, vol. 83, pp. 173-178. Australian Computer Society, Inc. (2007)
20. Mendling, J., Reijers, H.A., van der Aalst, W.M.: Seven process modeling guidelines (7PMG). Information and Software Technology 2010 vol. 52(2), pp. 127-36.
21. Holschke O., Rake J., Levina O.: Granularity as a cognitive factor in the effectiveness of business process model reuse. In Business Process Management 2009, pp. 245-260. Springer (2009)
22. Fettke, P., Loos, P.: Classification of reference models - a methodology and its application. Information Systems and e-Business Management 2003 vol., pp 35-53.
23. Frank, U.: Evaluation of reference models. Reference modeling for business systems analysis. 2007, pp 118-40.
24. Vom Brocke, J., Rosemann, M.: Handbook on business process management. Springer (2010)
25. Westland, J.: The Project Management Life Cycle: A Complete Step-By-Step Methodology for Initiating, Planning, Executing & Closing a Project Success. Kogan Page Publishers (2007)
26. Harmon, P.: Business process change. Morgan Kaufmann (2014)
27. Brocke, J.V., Rosemann, M.: Handbook on Business Process Management 2: Strategic Alignment, Governance, People and Culture. Springer Publishing Company, Inc. (2014)
28. Rosemann, M.: Potential pitfalls of process modeling: part A. Business Process Management Journal 2006, vol.12, pp. 249-254.
29. Raduescu, C., Tan, H.M., Jayaganesh, M., Bandara, W., zur Muehlen, M., Lippe, S.: A framework of issues in large process modeling projects. European Conference on Information Systems 2006, pp. 1594-1605.
30. Rittgen, P.: Success factors of e-collaboration in business process modeling. InAd-vanced Information Systems Engineering 2010, pp. 24-37. Springer Berlin Heidelberg (2010)
31. Lu, R., Sadiq, S.: A survey of comparative business process modeling approaches. Business information systems 2007, pp. 82-94. Springer Berlin Heidelberg (2007)
32. Yew Wong K.: Critical success factors for implementing knowledge management in small and medium enterprises. Industrial Management & Data Systems 2005, vol. 105, pp. 261-279.
33. Lantz, B.: Equidistance of likert-type scales and validation of inferential methods using experiments and simulations. The Electronic Journal of Business Research Methods 2013, vol. 11, pp. 16-28.
34. Yin, R.K.: Case study research: Design and methods. Sage publications (2013)
35. Kitchenham, B., Pickard, L., Pfleeger, S.L.: Case studies for method and tool evaluation. IEEE software 1995, vol. 12, pp. 52-62.
36. Cronje, G.J.D, Toit, G.S. D., Motlatla, M. D. C., Marais, A.D.: Introduction to business management. Oxford University Press (2003)
37. Ljung, L.: System identification. Birkhäuser Boston (1998)
38. Malinova, M., Mendling, J.: The Effect Of Process Map Design Quality On Process Management Success. European Conference on Information Systems 2013, paper 160.

39. Bhatt, G.D.: Knowledge management in organizations: examining the interaction between technologies, techniques, and people. Journal of Knowledge Management 2001 vol. 5, pp. 68-75.

Appendix

Group	Factors	Definition
Organization	Management Support	The level of commitment by senior management in the organization to the BPM activities in terms of their own involvement and the willingness to allocate valuable organizational resources.
	Clear Goals & Purposes	The clarity of goals and purposes of the BPM initiatives in the organization.
	Subjective Norms	The perceived opinions of a person or group whose beliefs may be important to the individual about process model re-use.
Process Modelling	Modelling Expertise	The experiences of process modellers in terms of conceptual modelling in general and process modelling in particular.
	Stakeholders Participation	The degree of input from users in the design, approval and maintenance of the models.
	Information Resources	Availability of information during the project.
	Project Management	The management of the process modelling project, including defining the project scope, aims, milestones, and plans.
	Modelling Methodology	A detailed set of instructions that describes and guides the process of modelling.
	Modelling Language	The grammar or the 'syntactic rules' of the selected process modelling technique.
	Modelling Tool	The software that facilitates the design, maintenance and distribution of process models.
Process Model	Richness	Availability of necessary information in the process model.
	Sematic Quality	The degree of correspondence between information conveyed by a process model and the domain that is modelled.
	Value of Knowledge	The degree to which a person believes (re-)using a particular process model will help to achieve the intended goal.
	Structure	The degree to which a person believes that finding necessary information from the model is simple.
	Ease of Interpretation	The degree to which a person believes that interpreting a process model would be effortless.
Tool	Ease of Use	The degree to which a person believes that the use of modelling software for using a process model would be easy.
	Usefulness	The degree to which a person believes that using a modelling software will be effective in using a process model.
User	Competence	The amount of knowledge the users have of the modelled domain and the use of the process models.
	Motivation	Using a process model for no apparent reason other than the task of using it, e.g. to gain knowledge of a process.
	Knowledge Networking	Users knowledge about the organization (processes) and willingness to share it.