ORGANISATIONAL ISSUES IN MODELLING BUSINESS PROCESSES: AN ACTIVITY-BASED INVENTORY AND DIRECTIONS FOR RESEARCH

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Abstract

This project aims to create a structured inventory of concerns related to business process modelling that may face organisations embarking on business process management (BPM) projects. Key issues are identified for each BPM activity stage, overarching patterns are noted, and suggestions are made for the future research agenda. Modelling is at the core of BPM, a practice which in recent years has developed maturity and become linked with managerial concerns such as innovation and knowledge management. Although it is well known that modelling business processes can be challenging for organisations, an inventory of known issues, which could be of use to organisations to plan and manage BPM projects, is missing. This study aimed to develop such an inventory. The scoping review method was adopted. The review protocol consisted of a search for related literature using keywords, complemented by forward and backward searches through citations and references. Analysis of these papers revealed 77 concerns. These concerns where then organised according to four key BPM activities (analysis, modelling, enactment, and management). Further analysis resulted in a collection of 18 sub-activities, which summarise and reveal which overall concerns are characteristic of BPM modelling. The nature of the evidence base for each concern is also broken down. We suggest that this study contributes to build a high-level understanding of process modelling issues faced by organisations when delving into process modelling practices. Furthermore, we suggest that understanding of how to address these issues can be increased through research into seven high level questions.

Keywords: Business Process Modelling, Business Process Management, Scoping Review.

1 INTRODUCTION

Industry surveys indicate that organisations are maturing their process orientation through Business Process Management (BPM), which is understood both as a technology and as a managerial method (Harmon and Wolf, 2011; Harmon and Wolf, 2014). Process modelling is one of the foundational characteristics of BPM (van der Aalst, 2013). Process models aim to capture the different ways in which work/business processes are handled in organisations, comprising two complementary aspects of business processes: the ordering of business activities and the creation and use of business data.

Although we can find multiple accounts of research in process modelling (Figl and Weber, 2012; Forster et al., 2013; Pinggera et al., 2013), organisations may still find it difficult to acquire a broad picture of the challenges that emerge when trailing process modelling. Previous reviews in the BPM field discuss various important aspects like selecting appropriate languages, technologies, frameworks, and paradigms (Aguilar-Saven, 2004; Aldin and de Cesare, 2011; Curtis et al., 1992; Melão, 2009; van der Aalst, 2013). However, the specific concerns tend to be scattered throughout a wide body of research literature. Perhaps an exception is the work of Rosemann (2006a; 2006b) who identifies six typical characteristics of unsuccessful process modelling related to strategy and governance, plus a number of pitfalls related to modelling practice, modelling tools, and maintenance issues. This paper contributes with a more comprehensive account, organised according to the BPM lifecycle activities.

Several recent trends increase the significance of process modelling for organisations and make it more pressing to understand its challenges: The process modelling practice has been evolving significantly, with an increase in complexity, sophistication and diversity. Modelling languages such as the Business Process Modelling Notation (BPMN) have been extended to cover the complexities of information management, communication, coordination and collaboration in organisations and businesses (Chinosi and Trombetta, 2012). Many process-modelling tools have also been improved with better model checking, visualisation and simulation capabilities. But what is perhaps more striking is that organisations have been demanding for business process modelling to extend beyond the technically-oriented havens, such as business process automation and optimisation, towards more holistic and strategic management applications, involving knowledge management, project mobilisation and business innovation (Hill et al., 2006; Melão, 2009). In such an evolving scenario, the challenges faced by organisations may be actually increasing.

The objective of this study is to answer the questions, “What concerns may be encountered in the practice of modelling business processes?”, and “How do these concerns relate to the key BPM activity stages?”. The research question is therefore left relatively open with the aim of including a broad base of evidence ranging from empirical data to researchers’ opinions: Although understanding of some problems has resulted from experimental research, many other issues have been reported by other types of research such as case studies, development projects and research essays.

Our strategy consists in identifying, analysing and summarising a list of concerns reported by the existing research literature. Since process modelling has a strong, rich research background but ultimately aims at providing practical value to organisations, the adoption of such strategy seems compelling. We combined this with the scoping review method (Paré et al., 2015) to examine the extent, range and nature of research literature on business process modelling. Scoping reviews are considered suitable to analyse the breadth of existing literature on a particular topic in a comprehensive way (Arksey and O’Malley, 2005; Paré et al., 2015).

We suggest that this study contributes to build a high-level understanding of process modelling issues faced by organisations when delving into process modelling practices. The paper is organised as follows: In the next section we describe the method adopted for this study. In section 3 we report and discuss the results. Finally, in Section 4 we provide some concluding remarks.

2 METHOD

The study used the scoping review method. This particular type of review is characterised by adopting the overarching goal of summarising prior knowledge, using a broad scope of questions, adopting a comprehensive search strategy, focussing on conceptual and empirical sources, and analysing findings through content or thematic analysis (Paré et al., 2015). We now describe the various steps that were developed and implemented for the study.

The review protocol involved three procedures: literature search, filtering and extraction of evidence through coding. The literature search covered journal articles, conference papers and PhD/Ms dissertations written in English and spanning the fields of information systems and computer science. The search considered various instruments including Google Scholar, ISI WoK, ACM DL, and SCOPUS. A diversity of instruments was considered necessary because we were seeking to include conference papers in our search, which are not considered in some databases but are highly relevant to computer science in general and BPM in particular. The importance of conference publications to the computer science field has been documented (Freyne et al., 2010) and we believe that excluding conference publications would significantly reduce the interest and representativeness of this study.

One important issue regarding literature search is defining appropriate search phrases and keywords. Building such phrases is problematic for several reasons. In this case, we faced two initial problems. One problem was that searching for the keywords "business," "process," "modelling" and "concerns" returned too many results (about 340.000 in Google Scholar and 2.200 in ACM DL). Using other keywords like "problems" in the search phrase lacked utility because they are common words appearing in most papers. However, searching for exact phrases like "business process modelling challenges" or "business process modelling issues" did not match any articles. We considered alternatives like searching for "business process modelling" plus a combination of "modelling" and various keywords like "breakdown(s)," "shortcoming(s)," "challenge(s)," "limitation(s)," and "difficulty(ies)." However, another problem we found when analysing the outcomes from these searches was low recall (Walters, 2009), i.e., that not all relevant papers seem to be elicited. For instance, we know that Rosemann (2006a; 2006b) discusses the topic but these studies did not appear in the search results. After multiple attempts, we could not find search phrases capable of providing good precision and recall in the literature search on modelling problems.

We therefore refined the search procedure by combining the low-recall search phrases previously mentioned with forward and backward techniques (Webster and Watson, 2002). Search phrases combining "business process modelling" plus the concatenation of "modelling" with several synonyms of "concern" were used to build an initial pool of papers. Then, the bibliographic section of each paper in the pool was analysed to identify and bring new papers to the pool (backward search); and Google Scholar citations were used to identify new papers citing papers in the pool (forward search). This procedure, which deemphasises the impact of keyword selection, was repeated several times until no new papers were added to the pool.

The forward and backward technique was then applied in combination with a filtering procedure designed to eliminate repeated papers (only new papers were added to the pool) and also papers that clearly were not addressing process modelling (only papers with titles, abstracts and keywords related to process modelling were added to the pool). As recommended by Brereton et al. (2007), the filtering procedure erred on the side of caution, only excluding papers in which the title, abstract and keywords clearly indicated that the research was not focussed on business process modelling.

After completing the search procedure, each paper was read to identify specific concerns (more details below). Each concern was then coded using an open coding approach (Miles and Huberman, 1994). An open, or inductive coding process avoids using predefined categories, which could introduce some research bias. Any paper not having an assigned code after this process was eliminated from the study. The protocol was developed and tested by one of the authors, who built a preliminary collection of 107 papers and applied the coding process to 20% of them. Another author was then trained on the protocol and subsequently conducted the literature search and coding process from scratch.

The initial search for keyword combinations resulted in the selection of 69 papers. The forward and backward procedures identified a further 64 new papers. The filtering procedure eliminated 15 papers that were unrelated to process modelling, and 13 papers were eliminated for not having any assigned code. Thus the collection of papers supporting the scoping review consists of 106 papers.

The adoption of the refined search procedure was a solid contributor to the quality of the review. Since the search procedure ended only after the forward and backward techniques stopped uncovering new papers, it helped build confidence because 1) a high number of papers were repeatedly identified (indicative of their relevance, as expressed through citations); and 2) the forward search allowed identification of recent publications of potential relevance that did not have yet a significant number of citations. Although the search procedure was iterative, the collection of papers rapidly converged to produce a manageable number. This may be indicative that we have asked the right question and that the protocol was suitable for addressing the question (Dyba et al., 2005). Although we cannot guarantee that all relevant papers were selected, the procedure clearly generated a high recall (Walters, 2009). Regarding the number of papers found and their temporal distribution, the obtained results are similar to a recent literature review on business process quality, which identified a set of 74 papers predominantly published between 2007 and 2012 (Moreno-Montes de Oca et al., 2015).

Data extraction involved reading the results, discussion and concluding sections of each paper. These sections are the ones that typically summarise research findings and consequently have more probability of reporting reflective accounts of concerns related to process modelling. We did not consider papers' abstracts because they may not be reliable (Brereton et al., 2007) and also because modelling may not be the actual phenomenon of interest.

In each paper, we searched for concerns related to process modelling, which may occur in different contexts and require some interpretation. For instance, Ball et al. (2004) say "[...] challenges occur such as representing decision-making of employees [...]", which highlights an interesting scenario where the decisions of the participants in a business process are often not represented. However, the concern is not presented in such a clear-cut way, as it is presented along with other issues and contextualised in a case involving stocks and customer orders. Another example, also from Ball et al. (2004), is the statement "discrepancies between physical stock and stock records", which actually refers to discrepancies between the flow of physical goods and the flow of information in business processes. All in all, data extraction required searching for concerns expressed in various ways and contexts.

In order to increase reliability, we classified concerns in three main evidence categories: research findings, declarative statements and opinions. Naturally research findings are stronger than declarative statements and opinions, which perhaps could have justified restricting the review to this category. However, we decided to include the other categories to accommodate the multidisciplinary characteristics of this research area, which comprehends a diversity of research practices in the engineering and IS fields, theoretical and applied investigative approaches, as well as different understanding about what constitutes a research contribution (Hevner, 2007).

Using an open, or inductive coding process, an initial set of descriptive codes was created to identify the different concerns described in the literature. In a second round of coding these codes were reviewed, analysed in detail and merged into categories reflecting similar areas of concern. Various types of categorisations where experimented, including one that was problem-centred, grouping concerns reflecting similar modelling problems. However, the categorisation that prevailed and which is presented in this paper adopts van der Aalst's four-part BPM activity framework (van der Aalst, 2013): analyse, model, enact, and manage. This framework covers most typical BPM projects and can classify process modelling concerns according to a working, actionable view that is particularly aligned with the organisational goals and actions. Therefore the adopted categorisation uses the abovementioned four activities as a first level of categorisation and groups concerns reflecting similar types of activities at a second level of classification.

Two authors participated in the first round of coding, working in successive steps until satisfied with the obtained descriptive codes. Furthermore, a third author randomly selected about 10% of papers for inspection and assessed the assigned codes for accuracy and suggested any necessary changes.

3 RESULTS

The results of the scoping review are shown in Tables 1-4, organised according to van der Aalst's four overarching BPM activities: analysis, modelling, enacting, and managing. For each activity, we identify the set of sub-activities that emerged from the analysis, displayed in the left column; and the list of specific modelling concerns found in the reviewed literature through the coding process, which are displayed in the right column. The columns shown in the middle report the number of concerns identified for each type of statement: F- research finding; S- declarative statement; O- opinion.

Analysis	F	S	O	
Planning	1			Deciding between art and standardisation (Trkman, 2010)
	1			Deciding between specialising or generalising (Trkman, 2010)
Training in analysis	2			Avoiding modellers' silo views and social distance (Kolb et al., 2014; Trkman, 2010)
Target selection		1	1	Avoiding low user consultation (Buchanan and McMenemy, 2012; Cabitza and Simone, 2013)
	1			Getting insights on business processes before modelling (Perumpalath, 2005)
	1			Identifying process owners (Trkman, 2010)
Data collection	2	2	2	Making the transition from business rules and goals to process models (Andersson et al., 2005; Behnam et al., 2010; Goedertier et al., 2008; Gordijn et al., 2000; Kovacic, 2004; Soffer and Wand, 2005)
			1	Linking human skills and behaviours to process models (Caetano et al., 2005)
	1			Gathering work experience from frontline workers (Cabitza and Simone, 2013)
	1			Capturing expertise and skills (Riemer et al., 2013)
	1			Integrating knowledge from people with diverse backgrounds (Gulla and Brasethvik, 2000)
	1			Capturing process dynamics (Ball et al., 2004)
	1			Dealing with workarounds (Clegg and Shaw, 2008)

Table 1. Concerns related to analysis (F- research finding; S- declarative statement; O- opinion).

We have found 13 concerns related to 4 sub-activities falling into the scope of analysis. Regarding planning, careful considerations should be done about the extent of standardisation and generalisation. Related to training in analysis, we found that modellers should be made aware of negative effects caused by being excessively centred on their own objectives (silo views, social distance). In the context of target selection, considerations have to be made on how to consult the stakeholders and how to gain preliminary insights about the business processes and their owners. However, most concerns in this category seem to be related with data collection. A broad challenge is how to transition business rules and goals into process models. Several papers refer to significant gaps between how companies and modellers view business processes, the former being more centred on skills, behaviours, soft-goals and rules, and the latter being more focussed on task decomposition and coordination (Andersson et al., 2005; Behnam et al., 2010; Goedertier et al., 2008). Also of consideration is how to capture the expertise and skills of the process participants, especially from frontline workers. Furthermore, we also found challenges related to the inability to capture workarounds, diverse practices, non-standard processes, and behavioural dynamics. As Cabitza and Simone (2013) explain, these concerns suggest it may be difficult to discover the "true nature" of social-technical practice when acquiring process-related information (Cabitza and Simone, 2013).

Modelling	F	S	O	
Selecting a language	4	1	1	Assessing the suitability of a modelling language (Ball et al., 2004; Recker et al., 2010; Recker et al., 2013; Russell et al., 2006; Wahl and Sindre, 2006; Wohed et al., 2005)
	1			Assessing the impacts of language on modelling (Muehlen and Recker, 2008)
Selecting a tool	2			Building holistic and contextualised views (Luukkonen and Mykkänen, 2012; Stuit, 2011)
		2		Linking different levels of abstraction (Gulla and Brasethvik, 2000; Lippe et al., 2005)
			1	Tracking sources of business rules (Bajec and Krisper, 2005)
	2		1	Graphical and non-graphical expressivity (Barjis, 2008; Leopold et al., 2012; Stuit, 2011)
	1			Support to behaviour analysis (Malhotra et al., 2007)
	1	1		Support to model checking (Barjis, 2008; La Rosa et al., 2013)
		1		Support to contextual information (Caetano et al., 2005)
	1			Support to complexity management (Nikolaidou et al., 2001)
	6	1		Understanding best practices (Bandara et al., 2005; Eikebrokk et al., 2008; Indulska et al., 2009a; Krogstie et al., 2008; Mendling et al., 2010b; Moody, 2004; Riemer et al., 2014)
	2			Understanding success factors (Melão, 2001; Melão and Pidd, 2000)
	2			Understanding structured process decomposition (Johannsen and Leist, 2012; Malinova and Mendling, 2013)
	2	1		Understanding mismatch between representational capabilities and reality (Krogstie, 2007; Lindsay et al., 2003; Recker et al., 2006a)
	2		1	Understanding factors affecting the selection of modelling methods (Bider, 2005; Luo et al., 1999; Rosemann et al., 2009)
	4		1	Exploiting modelling guidelines (Bandara and Rosemann, 2005; Becker et al., 2000; Derrick, 2012; Jun et al., 2009; Riemer et al., 2014)
	1			Exploiting generic model templates (Jaako, 1998)
Training in modelling	6	1		Understanding best practices (Bandara et al., 2005; Eikebrokk et al., 2008; Indulska et al., 2009a; Krogstie et al., 2008; Mendling et al., 2010b; Moody, 2004; Riemer et al., 2014)
	2			Understanding success factors (Melão, 2001; Melão and Pidd, 2000)
	2			Understanding structured process decomposition (Johannsen and Leist, 2012; Malinova and Mendling, 2013)
	2	1		Understanding mismatch between representational capabilities and reality (Krogstie, 2007; Lindsay et al., 2003; Recker et al., 2006a)
	2		1	Understanding factors affecting the selection of modelling methods (Bider, 2005; Luo et al., 1999; Rosemann et al., 2009)
	4		1	Exploiting modelling guidelines (Bandara and Rosemann, 2005; Becker et al., 2000; Derrick, 2012; Jun et al., 2009; Riemer et al., 2014)
	1			Exploiting generic model templates (Jaako, 1998)
Selecting methods	2			Representing business rules and work distribution rules (Green and Rosemann, 2001; Russell et al., 2006)
	1			Representing the system boundary (Green and Rosemann, 2001)
	1	1		Representing non-functional aspects of work, including waiting states and data flows (Aburub et al., 2007; Wohed et al., 2006)
	1			Balancing language power and intuitiveness (Rosemann, 2006a)
		2		Balancing bottom-up and top-down approaches (Bititci and Muir, 1997; Reijers et al., 2011)
	1		1	Balancing work routinisation and people's skills, expertise and behaviour (Elliman et al., 2005; Riemer et al., 2014)
	1			Expressing process variety (King and Johnson, 2006)
	1			Expressing contextual factors (Rosemann et al., 2006)
		1		Avoiding "one size fits all" solutions (King and Johnson, 2006)
Model management	1			Handing model reusability (Koschmider and Reijers, 2013)
	1			Handling model transformations (Melão, 2009)
	1	1		Describing inter- and cross-organisational processes (Gordijn et al., 2000; Lippe et al., 2005)
Handling	2	2		Handling complex models (Damij, 2007; Krob, 2006; Nikolaidou et al., 2001; Recker,

complexity				2010b)
	1			Integrating different levels of abstraction (Lippe et al., 2005)
	2	1		Simplifying and decomposing systems (Green and Rosemann, 2001; Kumaran et al., 2008; Lindsay et al., 2003)
	1			Dealing with process variations (Bendoly and Cotteleer, 2008)
	1	1		Handling complex coordination and collaboration requirements (Caetano et al., 2005; Wynn et al., 2005)
		1		Combining multiple modelling tecniques (Damij, 2007)
Self efficacy	4			Modeller's perspective on model quality (Davies et al., 2006; Giaglis, 2001; Koster et al., 2010; List and Korherr, 2006)
	2			Modelling usage intentions (Recker, 2008; Recker, 2010a)

Table 2. Concerns related to modelling (F- research finding; S- declarative statement; O- opinion).

Unsurprisingly, the modelling activity itself is the one that raises most concerns. We found 38 concerns, which we grouped in the 7 sub-activities that we could identify in this category. A sub-activity that seems to raise significant concerns is related with training. The related literature points out the need to understand existing best practices and how-to guidelines (Bandara et al., 2005; Eikebrokk et al., 2008; Krogstie et al., 2008), modelling success factors (Melão, 2001), and typical modelling problems such as dealing with process decomposition (Malinova and Mendling, 2013). Significant concerns also emerge about language, tool and method selection (Bajec and Krisper, 2005; Caetano et al., 2005; Luukkonen and Mykkänen, 2012; Melão, 2009). Selecting methods seems to be difficult because of the diversity of information involved in process modelling: graphical and non-graphical, abstract and concrete, holistic and contextualised, coordinated and collaborative. Furthermore, these difficulties seem to be compounded by existing difficulties dealing with complexity (Bendoly and Cotteleer, 2008; Damij, 2007; Nikolaidou et al., 2001).

Some concerns reported in this category highlight several limitations of current process-modelling notations (Gordijn et al., 2000; Lippe et al., 2005). For instance, the need to better represent business rules, inter- and cross- organisational processes, and going beyond mere work routinisation, seem to call for a broader scope than the typical workflow patterns (Andersson et al., 2005; Riemer et al., 2014).

Enactment	F	S	O	
System configuration	2			Defining enactment rules (Dehnert and van der Aalst, 2004; Morgan, 2007)
	1	1		Accomodating constraints imposed by automation (Kumaran et al., 2008; Trkman, 2010)
		1		IT bottleneck (Kumaran et al., 2008)
People configuration	1			Assessing factors that influence acceptance and use (Eikebrokk et al., 2011)
	1			Assessing end-user capability to adjust plans (Weber et al., 2009)
	1		1	Motivating employees for change (Eikebrokk et al., 2011; Trkman, 2010)
	1			Securing management support (Trkman, 2010)
Model checking	3	2		Reducing gaps between model and function (Andersson et al., 2005; Dehnert and van der Aalst, 2004; Kumaran et al., 2008; Lindsay et al., 2003; Mentzas et al., 2001)
		1		Checking task accuracy (Dunn and Grabski, 2000)
	1			Dealing with flexibility (Pesic, 2008)

Table 3. Concerns related to enactment (F- research finding; S- declarative statement; O- opinion).

In the enactment category we found 10 concerns which we grouped in 3 sub-activities, all related to gaps between enacted models and reality (Dehnert and van der Aalst, 2004; Kumaran et al., 2008). Regarding system configuration, one has to consider enactment rules, accommodating the constraints raised by IT groups on changes brought by new operative processes. People must also be considered

when enacting business processes; this includes assessing the factors that affect system acceptance and use, human capability to adapt to new operative processes, and securing managerial and employee support for change. At a more technical level, we also identified issues regarding model checking caused by gaps between process models and operations, task inaccuracies and lack of flexibility.

Management	F	S	O	
Quality management	6	1	1	Clarifying what is model quality (Fetke et al., 2014; Heravizadeh et al., 2009; Hommes, 2004; Hoppenbrouwers et al., 2009; Mendling et al., 2010b; Recker, 2007; Sadowska, 2013; Sánchez-González et al., 2010)
	2			Establishing quality assessment (Fetke et al., 2014; Sadowska, 2013)
	1			Handling model validation (Jaako, 1998)
	1	1		Assessing usefulness (Davies et al., 2004; Jun et al., 2009)
	6	1		Assessing understandability and expressiveness (Dunn and Grabski, 2000; Houy et al., 2012; Lohrmann and Reichert, 2012; Mendling et al., 2009; Mendling et al., 2010a; Mendling and Strembeck, 2008; Rosemann, 2006b)
		1		Assessing process decompositions (Johannsen and Leist, 2012)
		1		Assessing models beyond a static view (Krogstie et al., 2006)
		2		Defining guidelines about completeness and correctness (Derrick, 2012; Dijkman et al., 2008)
Communication	1			Defining shared frame of reference between business and IT (Lankhorst 2005)
	1	1		Establishing a common understanding of terms (Aguilar-Saven, 2004; Koster et al., 2010)
	2			Communicating the benefits from modelling initiatives (Indulska et al., 2009a; Recker et al., 2006b)
	2			Reducing gaps between communication and implementation goals (Derrick, 2012; Goedertier et al., 2008)
Decision making		1		Selecting modelling language (Recker, 2010b)
	1			Selecting modelling tools (Giaglis, 2001)
	1			Defining model re-use (Nolte et al., 2013)
Tracking		1		Tracking lifecycle data and process history (Hull, 2008)

Table 4. Concerns related to management (F- research finding; S- declarative statement; O- opinion).

Finally, in the management category we find 16 concerns related with 4 sub-activities. The emphasis on quality management is overwhelming. Multiple studies note the difficulties establishing model quality (Fetke et al., 2014; Heravizadeh et al., 2009; Sadowska, 2013; Sánchez-González et al., 2010), where many properties like usefulness and understandability have to be clarified and settled (Davies et al., 2004; Houy et al., 2012).

4 DISCUSSION AND CONCLUSIONS

This study has illuminated the range and extent of concerns in business process modelling, resulting in a structured set of categories and subcategories linked to the framework of essential BPM activities. Organisations wishing to embark on a BPM project should consider the 18 sub-activities identified by this study and the various concerns that, within each category, may arise. This classification can be used for planning and negotiating project goals, and also for assessing project risks.

From the final list of papers for which modelling concerns were coded 41.51% were published in journals, 35.85% in conferences, and 19.81% correspond to other types of publications (theses and book chapters). This gives a good indication of the quality of the data on which the current study is based. Interestingly, we note that from the number of papers published in journals and conferences, 51.22% are related to Computer Science (CS) and 48.78% are related to Information Systems (IS). This indicates that concern with modelling is almost equally divided between the two fields, and suggests that the area may need to be tackled in a multidisciplinary way. Between the fields, however, there is a notable difference in distribution across publishing outlets: whereas only 13.41% of the

papers published in journals and conferences were published in CS journals, 35.85% of the collection were published in IS journals. Conversely, whereas 37.8% of the papers published in journals and conferences were published in CS conferences, only 8.54% were published in IS conferences. These differences are typical of the differences in research distribution between the IS and CS fields. Excluding conference papers would have significantly impacted the quality and nature of the results. Finally, we note that 4.72% of the papers on which this study was based were published in the IS basket of eight top journals. This can be seen as evidence of not only the quality of this research but also a sign of the significance of business process modelling to the IS field.

The inventory of modelling concerns, while useful in its own right, provides greater value in enabling the identification of key overarching issues facing organisations in their BPM endeavours. By extension, it can assist in identifying key research challenges and suggested goals for the future research agenda. We conclude by outlining some of the key high level issues and the implications for research and practice.

The study has highlighted not only the extent of BPM modelling concerns across the BPM activity cycle, but also the extraordinary complexity of BPM challenges facing managers. For example, it is apparent that significant "fine tuning" is required in order to successfully align the modelling practice with the target organisations. The inventory highlights the fact that organisations may face a myriad of issues relating to the need to decide between, or balance, alternative BPM-related courses of action. They may need to rely some degree on trial-and-error decisions and negotiations with modellers regarding how to deal with multiple aspects of process modelling such as deciding on bottom-up or top-down approaches, translating business rules into workflows, handling different levels of abstraction, tackling workarounds, contextualising models to particular stakeholders, and building consensus with project leaders about what model quality is and how it can be assessed. They must also consider the problems of collecting the right data from the targeted business processes. We suggest that a process of mutually understanding and negotiating the various concerns of process analysis and modelling is necessary to align the organisations' with the modellers' expectations.

Further research should be undertaken to help elucidate this area. For example, exploratory studies could be based around the broad question, (1) "How can organisations be supported in the complexities of BPM-related decision-making?" Research in this line might explore the nature of supporting competencies, tools and activities. As the "correct" decision in terms of a course of BPM-related action is likely to differ according to different aspects of organisational context, future research should also consider the questions, (2) "What is the relationship between BPM approaches and organisational context?" and, (3) "How can organisations identify the key contextual issues impacting on BPM decisions?" Given the sheer number of issues involved in BPM, it is also necessary to increase understanding relating to the nature and extent of risks associated with different BPM challenges, so as to help guide and focus organisational efforts and priorities. We also recommend research into the broad question, (4) "What is the nature of risk associated with BPM activities?"

It is apparent that a key organisational concern relating to BPM arising from this review concerns model quality. Specifically, we note the need for organisations to clarify what should constitute model quality and how quality will be assessed. Such clarifications extend beyond structural and textual quality (Mendling, 2013; Mendling and Recker, 2007). It seems necessary for organisations to define adequate levels of understandability/expressivity, decomposition, completeness/correctness, and static and dynamic fluency. The lack of clarity about these concerns at the early stages of a project may leave process modellers without guidance, and in the latter project stages, may leave managers with reduced capacity to gain insights into, and control over, the desired modelling outputs. We suggest that this study may contribute to help modellers and organisations to reduce the gap between the technical/hard view and the business/soft views of modelling in BPM. Future research should address the questions, (5) "What constitutes model quality in BPM from an organisational perspective?" and (6) "What methods are most adequate to assess quality from an organisational point of view?"

Another aspect to ponder is the semantically rich notion of work that emerges from Tables 1 to 4. This includes reconciling conflicting facets such as functional and non-functional aspects of work, standard behaviour and workarounds, business rules and workers' expertise and skills, coordination and

collaboration, inter and cross-organisational processes. Apparently this rich notion of work has yet to find a proper way of being represented in process models, since most existing approaches emphasise a functional view. We recommend research into the question, (7) "What alternative theoretical foundations can be adopted for BPM modelling?"

This study also highlights future research steps. One such step concerns evaluating the value brought by Tables 1-4 to organisations, for instance the actual or potential impact on planning, negotiating and assessing business process modelling initiatives. We envisage using focus groups to assess the perceived value of the list of concerns and BPM activities and sub-activities. Furthermore, these focus groups could also help developing a standardised checklist for organisations to use when preparing BPM projects, which was outside the initial scope of this work but now seems a natural next step.

Another reasonable next step to consider is developing a decision-support tool, which would provide recommendations based on an assessment of the specific organisational context, would support the analysis of multiple what-if scenarios, and could provide an appreciation of project risks, for instance derived from inadequate training of lack of negotiation with modellers. Unfortunately the BPM community lacks such an integrated resource and therefore practitioners have to rely on scattered research accounts, case studies and generic frameworks.

This study focussed on findings, declarative statements and opinions published in specialised research publication outlets, focussing on the organisational perspective. It complements previous data collection on current issues and future challenges perceived by researchers, practitioners and vendors of BPM modelling tools (Indulska et al., 2009b). A future research line could consider complementing these sources of information with more vivid accounts of actual modelling practice. For instance, technical discussion forae from the major vendors of modelling tools could contribute as an alternative source of information.

In Table 5 we provide a summary of implications for practice and research suggested by this study. The table reflects the multidisciplinary nature of BPM, suggesting directions for research in the IS and CS domains.

Domains	**Issues**	**Suggestions/Implications for practice**	**Suggested directions for research**
IS theory	Aligning modelling practice with the target organisations	Organisations should negotiate with modellers several critical aspects of the BPM modelling practice: bottom-up versus top-down approaches; translating business rules into workflows, handling multiple levels of abstraction, modelling workarounds, contextualising models to stakeholders	Exploratory studies around a set of broad questions relating organisational context and business process modelling
IS Methods	Model quality	Organisations should clarify their objectives and views regarding model quality and assessment, emphasising the business/soft view	To investigate what constitutes model quality from a business/soft view and what methods can be used for quality assessment in organisational contexts
IS and CS theory	Work richness and model complexity	Business process models should convey work richness, including non-functional aspects of work, workarounds, business rules, workers' expertise and skills, coordination and collaboration,	To identify alternative theoretical lenses reflecting work richness in business process models

		inter and cross-organisational processes	
Design Science (IS and CS)	Decision making	Lack of support to planning, negotiating and assessing business process modelling initiatives	Develop new decision-support tools specifically addressing BPM project management

Table 5. Summary of implications suggested by this study.

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