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A Model-Driven Method for the Systematic Literature Review of Qualitative Empirical Research

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Abstract

This paper explores a model-driven method for systematic literature reviews (SLRs), for use where the empirical studies found in the literature search are based on qualitative research. SLRs are an important component of the evidence-based practice (EBP) paradigm, which is receiving increasing attention in information systems (IS) but has not yet been widely-adopted. We illustrate the model-driven approach to SLRs via an example focused on the use of BPMN (Business Process Modelling Notation) in organizations. We discuss in detail the process followed in using the model-driven SLR method, and show how it is based on a hermeneutic cycle of reading and interpreting, in order to develop and refine a model which synthesizes the research findings of previous qualitative studies. This study can serve as an exemplar for other researchers wishing to carry out model-driven SLRs. We conclude with our reflections on the method and some suggestions for further research.

Research Methods

Keywords: Systematic literature review, evidence-based practice, qualitative research, BPMN

Introduction

This paper discusses a model-driven method for systematic literature reviews (SLRs), for use where the empirical studies found in the literature search are based on qualitative research. The method starts with a tentative model which drives a systematic and documented literature review and synthesis, and they in turn refine the model. We illustrate this model-driven approach via an example SLR which focused on the use of BPMN (Business Process Modelling Notation) in organizations. We provide a detailed discussion of the process followed and show how the model-driven method is based on a hermeneutic cycle of reading and interpreting, in order to develop and refine a model which synthesizes the research findings of qualitative studies. We also situate our study in the context of the evidence-based practice (EBP) paradigm.

The argument for EBP and a model-driven approach to SLRs for qualitative research (Pawson 2006) was made to an IS audience by Oates (2011), but without a worked example, and to the best of our knowledge no SLR in IS has yet adopted this particular model-driven approach. This paper therefore builds on Oates' earlier work. The aims of our research were:

- To investigate the model-driven approach to SLRs (Oates 2011; Pawson 2006)) via an example (based on BPMN).

- To undertake a model-driven SLR of the available empirical evidence to discover what factors influence the effective use of BPMN in business organizations.

The focus of our example model-driven SLR was BPMN in use because it has been widely taken up by business organizations and is seen as the de facto standard for business process modeling (Recker et al 2010). It is increasingly viewed as adding methodological and design rigor to organizational change projects where complex and resource intensive technologies are intended to be adopted and deployed. One of the authors has worked as an academic consultant for large companies adopting BPMN and its supporting tools. Given such interest and the power of the industry-led consortium, www.bpmi.org (mainly software applications and tool vendors), he wanted to know what could be learnt in terms of both practice and theory from the empirical evidence about the effective use of BPMN in organizations.

SLRs are an important component of the evidence-based practice (EBP) paradigm. There have been calls for the adoption of EBP in IS (e.g. Atkins and Louw 2000; Moody 2000; 2003), where practitioner decision-making is informed by analyses and syntheses of high-quality empirical research, but it is not yet as well-established in IS as it is in other disciplines. Our paper therefore includes a brief overview of this paradigm and an explanation of the role of SLRs within it. We hope that the paper will stimulate more IS researchers to explore and develop the EBP paradigm.

The structure of the paper is as follows. The next section summarizes the EBP paradigm, explains the importance of SLRs within it, and summarizes the arguments for a model-driven method for SLRs within EBP for synthesizing qualitative research, in contrast to the conventional SLR approach. The following section provides a brief overview of BPMN. Then we demonstrate the model-driven method of an SLR, examining the empirical evidence concerning the use of BPMN in organizations, which leads to our model of the effective use of BPMN, and we draw some conclusions about our findings concerning BPMN. Finally we reflect on the use of this model-driven method for SLRs and suggest areas for further work. Overall our main contributions are:

- A detailed worked example of the model-driven approach to SLRs for qualitative research including our reflections on the method and the hermeneutic process followed.

- The outcome of our worked example: a model derived from previously published qualitative case studies of the factors that influence the effective use of BPMN in organizations.

Evidence-Based Practice and Systematic Literature Reviews

Across many disciplines it has been observed that practitioners often base their decisions on in-house expert opinion, gut feeling, or current fashion, without being aware of relevant academic research; if they do consult the academic literature they find it confusing, often contradictory, and hard to access (Atkins

and Louw 2000; Sackett et al 1996). As Oates (2011) explains, evidence-based medicine began to be developed in the early 1990's in response to such a situation in health care. It was argued that clinical practitioners should move from decision-making based on habit, prejudice, consultant's authority or imperfect knowledge of relevant research. Instead they should search the literature for the best available empirical evidence, critically appraise the study methods to assess the reported research results' validity, and combine this evidence with the values and preferences of their patient to make the best possible decisions about the patient's treatment (Sackett et al 1996). Evidence-based medicine is now seen as one of the 15 greatest medical milestones since 1840 (Montori and Guyatt 2008), and is now used to inform decisions about not only the clinical treatment of patients, but also, for example, strategies to change organisational culture to improve healthcare performance (Parmelli et al 2011), or approaches for promoting the adoption of information and communication technologies by healthcare professionals (Gagnon et al 2009).

As evidence-based medicine grew, it became apparent that practitioners often did not have the time or skills to search for all the available evidence, assess its validity and synthesize the findings of the high-quality studies. Researchers needed to conduct such studies, and a knowledgebase was needed which contained the current state of knowledge on the most effective treatments for diseases and other health problems, and summaries of the evidence for a non-academic audience. The Cochrane Collaboration (www.cochrane.org) was therefore established, a web-based knowledgebase which includes more than 5000 SLRs (Cochrane Collaboration 2012), with the main findings summarized in a form that practitioners and patients can read.

Evidence-based practice (EBP) has now spread to other disciplines, and web-based knowledgebases similar to the Cochrane Collaboration have been established, for example, the Campbell Collaboration contains SLRs in education, crime and justice and social welfare (www.campbellcollaboration.org), and a website for SLRs and evidence-based software engineering has recently been established (www.ebse.org.uk). There have also been calls for EBP and a web-based knowledgebase to be established in IS (Atkins and Louw 2000; Baskerville and Myers 2009; Moody 2000; 2003). As in other fields, IS practice should, where possible, be based on rigorous empirical research findings rather than gut feeling or current fashion about the latest "silver bullet". The EBP paradigm in IS would inform decisions about the adoption of new tools, methods, processes or software systems, as decision-makers would be able to draw upon the synthesized findings of empirical research studies into previous use of the tools, methods etc. Webster and Watson (2002) associate the lack of evidence base and theoretical progress in the IS field by highlighting the need for more rigorous reviews that do not just repeat a formula of listing endless citations but actually utilise a guiding theory and/or a set of competing models. They state that "the author's contribution would arise from the fresh theoretical foundations proposed in developing a conceptual model" (Webster and Watson 2002: xiv). In this paper we explain and illustrate one approach to developing and refining such a conceptual model.

In order to achieve EBP, four main elements are needed: 1) empirical research into the use by individuals, groups or organizations of tools, methods, processes or systems, 2) systematic reviews of the literature, which find all such empirical studies (the evidence) and synthesize their findings, 3) collections developed of these SLRs in easily accessible databases for use by both researchers and practitioners, and 4) knowledge transfer of the findings of SLRs to practitioners and other stakeholders. IS has a rich tradition in the first of these elements: empirical research into the use of IT, and many associated methods and tools, in social settings such as business organizations. But the concept of EBP itself is not yet widely known in IS, and the remaining three elements are not as well-developed as the first. This paper concentrates on the second element: systematic literature reviews (SLRs), and a new model-driven method for conducting them.

In EBP a systematic review of the literature analyzes and synthesizes published empirical studies concerning a method or artifact, in order to establish the evidence for its effectiveness. In many research papers it is not made explicit how the literature was searched for relevant previous work. In a systematic review, in contrast, the researchers develop a review protocol and document all stages, showing which journals or databases were searched and how, making the whole process transparent and traceable, so that it can be evaluated or repeated by other researchers. For example, Kitchenham (2004) describes the following stages of a SLR, all of which should be fully documented:

- Define a research question.

- Define a traceable and repeatable strategy for searching the literature (e.g. search terms and databases to be used).
- Search the literature for primary studies.
- Decide which candidate articles to include or exclude, using explicit selection criteria.
- Assess the quality of the research studies found and hence the validity of their findings.
- Extract and process the data from each high quality study (e.g. the intervention, size of population, findings, effect size).
- Synthesise the studies, using statistical meta-analysis.
- Write report and disseminate.

These stages are the conventional EBP approach to SLRs across many disciplines. Oates (2011) describes a search of the articles in the Association for Information Systems (AIS) eLibrary, looking for articles that mentioned EBP or SLR in their abstract. She shows that there were few such articles, and even those that claimed to have conducted a SLR did not describe a repeatable review protocol and were vague about the keywords used in searches, or which databases had been searched. These observations also link to Webster and Watson's (2002) findings that arise from working with senior reviewers of MISQ: they detected that many claimed SLRs only reviewed articles in North American, or a small set of "top", journals, neglecting many other publication outlets. Oates (2011) also argues that the SLR process as set out above (Kitchenham 2004) is often inappropriate for IS research, particularly for qualitative research (Boell and Cezec-Kecmanovic 2011; Oates 2011), as we summarize below.

Conventional SLRs in the EBP paradigm require a clearly-defined research question at the start, which usually focuses on "does it work?" – whether some change or intervention brings about a successful outcome. (By "intervention" in IS we mean the introduction of a new IS tool, method, process or software system.) Randomized controlled trials are most highly rated and their findings are synthesized via statistical meta-analysis techniques which combine the effect sizes of individual studies, with the aim of estimating the true effect size as opposed to a less precise effect size derived from a single study (e.g. Wilson and Lipsey 2001). Conventional reviews also have an underlying philosophy of positivism in seeking to identify a single reality and causation ("If X is applied then Y will occur" e.g. "If tool X is used then improvement Y will occur). Such conventional SLRs have been carried out in, for example, evidence-based software engineering (see www.ebse.org.uk). As Oates (2011) argues, however, such an approach to SLRs is less suited to much IS research. Rather than answering the simple question "does this intervention work?" and estimating an effect size, IS researchers often wish to explore multiple facets of the use of an IS method, tool or system, including both social and technical aspects (Boell and Cezec-Kecmanovic 2011). IS researchers and practitioners need to find out why an IS-related change is sometimes perceived as successful, sometimes unsuccessful and sometimes "a bit of both" (Oates 2011; Pawson 2006). Oates (2011) also argues that in IS it is difficult to design randomized controlled trials and to establish definitive causal relationships, because many variables, both social and technical, can affect the outcome of any IS change, so that in IS it is rarely possible to compare the effects of an intervention against a control group. Also, studies situated in the interpretive or critical paradigms, using qualitative data, are increasingly common in IS. These paradigms recognize that any information system or technical artifact is inserted into pre-existing social conditions comprising people, perceptions, relationships, culture, organizations, politics and structures. The intervention changes the people, perceptions etc; at the same time, the intervention is shaped and modified by the people who implement it or who are affected by it. Thus apparently similar organizations may experience different outcomes from an IS intervention. Hence trying to find out "does it work?" is too simplistic an approach to SLRs for much of IS, and a richer synthesis of empirical research is needed if EBP is to become a reality in IS. (For a fuller discussion of the limitations of conventional SLRs for EBP, see Oates (2011) and Pawson (2006)).

Oates (2011) therefore argues for a richer and more nuanced approach to SLRs for EBP in IS, drawing on the work of Pawson, a social policy researcher (Pawson 2006), where the review is explanatory rather than summative. This is a model-driven approach to SLRs, summarized by Pawson (2006) in six stages, and by Oates (2011) in eight stages, which are iterative rather than linear (see also Figure 1 below):

1. Devise an initial tentative model (or 'theory') about how the intervention might be effective.

2. Define a traceable and repeatable strategy for searching the literature.

3. Search the literature for primary studies, looking for empirical evidence to test the model, supplement it and refine it.

4. Decide which candidate articles to include or exclude based on their relevance to one or more parts of the emerging synthesized model.

5. Assess the quality of each research study for the strength of the evidence it offers to support or contradict parts of the emerging model.

6. Analyse the data looking for which bits of data are pertinent to which parts of the emerging synthesized model (i.e. each empirical article found is treated as a case study for the emerging model).

7. Synthesise the studies into a refined model which increases our understanding of how and in what circumstances an intervention may work (or not).

8. Write up and disseminate.

The review starts with a tentative model, and the subsequent stages test, shape and refine this model. All stages are fully documented, so that readers can evaluate the search process followed, the analysis and synthesis of previous research and the emergence of the final model. Webster and Watson (2002) advocate taking a concept-centric (as opposed to an author-centric) approach to an SLR where the concepts determine the organizing framework of the review, and a conceptual model may be the outcome of the literature search and synthesis. In the approach described here, the review starts with a conceptual model, which evolves as the review progresses. Such a model-driven review does not provide a summative verdict as in a conventional SLR for EBP, but explores and develops a model which can encapsulate both social and technical aspects. For researchers the review helps to accumulate knowledge about "what works for whom in what circumstances and in what respects" (Oates 2011; Pawson 2006; Webster and Watson 2002). For practitioners the review enables them to reflect on how the complex and inter-related elements that the review has modeled map to their particular situation and practices. We trialed this eight-stage approach and illustrate it below via a model-driven SLR to investigate what factors influence the effective use of BPMN in business organizations.

Business Process Modeling & BPMN

Business process modeling is the act of capturing and describing the processes, tasks, activities, roles and events in and across organizations to redesign, develop or change organization structures, and adapt, configure or develop new information systems. It often enables innovation of new business models using new technologies and work practices. Organizations must choose an appropriate business modeling method or technique and supporting tools. Business Process Modeling Notation (BPMN) is one method that is rapidly gaining academic and industry interest, supported by tools such as ARIS Express (www.ariscommunity.com).

BPMN was developed by the Business Process Management Initiative (BPMI), and is now maintained by the Object Management Group (the two organizations merged in 2005). The first BPMN version was released in 2004; the current version as of March 2011 is BPMN 2.0 and as of October 2011 the BPMN website (www.bpmn.org) defines it as an industry standard with 72 major organizational implementations (including Fujitsu, ITpearls, SAP and Oracle). White (2004) defines the objective of BPMN as: "to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes." BPMN contains constructs to support business process modeling, such as: Event, Activity, Gateway (Flow objects); Sequence Flow, Message Flow, Association (Connecting Objects); Pool and Lane (Swimlane Objects); Data Object, Group, Annotation (Artifacts). It enables business analysts and developers to show the sequence of business processes, how they are coordinated, and the messages that flow between different participants in related activities. BPMN has been viewed as a modeling tool and is attracting interest and development given its executable aspects (process "choreography") and adherence to a common standard (Object Management Group (OMG)-compliant).

We decided to trial the model-driven method for a SLR (Oates 2011; Pawson 2006), as outlined in the previous section, by carrying out a SLR to answer the question, "What factors influence the effective use of BPMN in business organizations?".

Example: Model-driven Systematic Review of BPMN

In this section we describe in detail the process we followed in our model-driven systematic review of BPMN and the results obtained, and reflect on the difficulties encountered. Figure 1 (below) summarizes the process stages. The model-driven SLR was undertaken by three researchers at three different universities, taking on different roles and activities within the study (Lencucha et al 2010): individually executing the same tasks (e.g. paper analysis), individually executing unique tasks (e.g. documenting researcher experience) and collaborative work (e.g. eliciting the initial model, or developing shared interpretations).
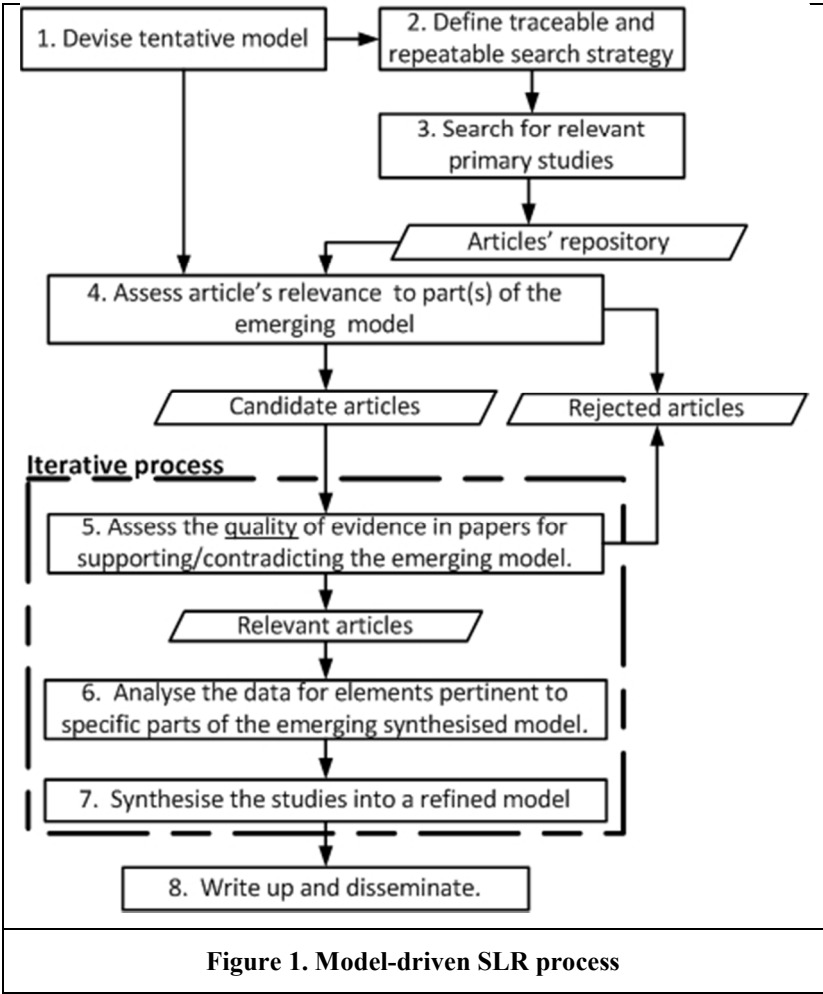

Figure 1. Model-driven SLR process

Process adopted

Stage 1 aims to "devise an initial tentative model about how the intervention might be effective". Our initial model was inductively developed. One team member had been an academic consultant on several BPMN projects. A rich picture drawing technique derived from Checkland's (1981) Soft Systems Methodology (SSM) was utilized to capture his experience of a procurement project involving BPMN within a large defense company (Wainwright and Brooks 2010). The rich pictures were used for a collaborative discussion (also drawing on the team's experience in BPMN and systems analysis) to extract themes/concepts that seemed likely to underpin any practice-based BPMN project. The themes were

combined in an initial model (Figure 2), based on: deciding to model business processes, choosing BPMN, tools, actors and roles, planned/emergent use of BPMN and achievement of the original objectives (or not), supported by enablers and hindered by barriers.
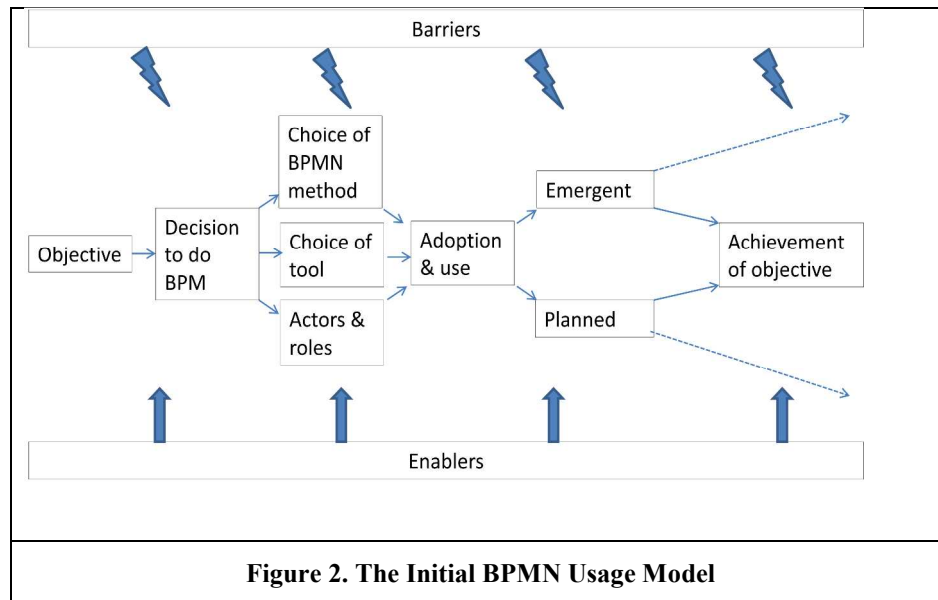

Figure 2. The Initial BPMN Usage Model

Clearly this model is derived from a reflexive discussion of the initial research/consultancy project and the combined experiences of the three researchers; it is a shared interpretation. Webster and Watson (2002) also find that the reasoning and justification for propositions and conceptual models may come from either past empirical findings or practice and experience (including the author's own experience). In this sense we adopted a 'soft operations research' definition of a model as representation of concepts relevant to the real world (Pidd, 2004) where the data was explicitly observer dependent and based on judgment, opinion and some ambiguity; the model was therefore a means to facilitate and support our learning from the SLR.

In Stage 2 we "defined a traceable and repeatable strategy for searching the literature". We limited the review to papers written in English, and bibliographical databases to the electronic ones covering IS, Business and Management, Computing and Engineering, to which at least one member had access via their university library (identified in Table 1). We agreed to search for "BPMN" or "business process modelling notation", or "business process modeling notation" in the title, abstract or keywords. Stage 3 required that we "search the literature for relevant primary studies", looking for empirical evidence to test the model, supplement it and refine it". Table 1 (below) shows the number of papers found in each database that appeared to contain some empirical evidence.

Stage 4 "Decide which candidate articles to include or exclude based on their relevance to one or more parts of the emerging synthesized model") was undertaken by skimming each paper's abstract or, where necessary, full text, to identify those which appeared to report empirical studies, whether in an organization (EO) or a classroom (EC) (see Table 1 below). We wanted to examine BPMN in use in organizations. This led to 29 EO papers to be analyzed and synthesized. To make the search protocol and its results explicit we also noted the search date and searcher's initials. Stages 5 and 6 were undertaken in parallel for this study, but independently by the authors; we each read a subset of papers to "assess the quality for the strength of the evidence it offers to support or contradict parts of the emerging model" and to "analyse the data looking for which bits of data are pertinent to which parts of the emerging synthesized model". To build in consistency and traceability the detailed analysis of each paper was recorded in a template. This template recorded the paper's title and authors, then had the nine elements of the initial model (given in Figure 2) as headings plus "Other comments" (e.g. research quality) and "Emergent themes" and finally the reviewer's initials. In Stage 7 ("synthesize"), the data in the analysis documents from Stage 6 were synthesized to develop a refined model which increases our understanding of what factors may influence the effective use of BPMN in business organizations. Stages 5-7 necessitated

iteration and frequent discussion between the three researchers to develop shared interpretations and agree emergent themes or refinements to the model. Finally Stage 8 "write up and disseminate" is started in this paper.

Model-Driven SLR: Results, Synthesis, Discussion

The result of applying the search process defined above is shown in Table 1. The number of papers found has not been aggregated since some were returned by more than one database. Although our initial searches produced large number of papers, we quickly discovered that few studied BPMN in use in organizations. Many papers described either the development of BPMN support tools, or extensions to the notation, rather than the organizational use of BPMN.

Table 1. Number of papers returned by the databases searched		
Database	**Searcher/ Date of search**	**Number of papers**
ACM Digital Library	AUT-2: 13/10/11	39 (2 EC, 0 EO)
AIS-elibrary	AUT-1: 17/10/11	26 (7 EO)
Business Source Elite	AUT-2: 13/10/11	20 (3 EO)
CSDL [IEEE(CS) Digital Library]	AUT-2: 18/10/11	35 (2 EO)
EMERALD	AUT-2: 17/10/11	3 (1 EO)
IEEE Xplore	AUT-1: 21 & 24/10/11	165 (3 EO)
Ingentaconnect	AUT-2: 17/10/11	8 (2 EO)
Inspec	AUT-2: 17/10/11	106 (18 EO)

(AUT = Author, EO = Empirical study in an organization, EO = Empirical study in a classroom)

Table 2 (below) shows those papers that were skimmed, subsequently read and then judged to have some data on the organizational usage of BPMN. This table began with 29 entries; of these we could not access three within the timescale of the study. These were all returned by the Inspec database and may still offer some insights: the abstract for Ciaramella et al (2009) refers to "some practical application of this framework through a real-world experience on a leather firm", Rolon et al (2008) discuss their work in an institution in the health sector, and Mendoza et al (2010) offer "a real-life example in the field of the Customer Relationship Management (CRM)". Any future review should examine them in detail for inclusion. 26 papers were individually analyzed and it emerged that six had no relevant empirical data, or researcher reflections, leaving us with only the 20 papers shown in Table 2 to use in our model-driven SLR. Within this subset both quantity and quality of information about organizational usage was, in general, very poor, as we discuss below.

We did not search all databases but only those that we judged most likely to return relevant results (i.e. those covering IS, Business and Management, Computing and Engineering). Furthermore we did not use any practitioner or grey literature which might include commentary on the organizational use of BPMN, concentrating instead on peer-reviewed academic sources. For the CSDL database the search protocol had to be changed to search for the specified terms in the title field only as the other search filters (abstract or keywords) were not available.
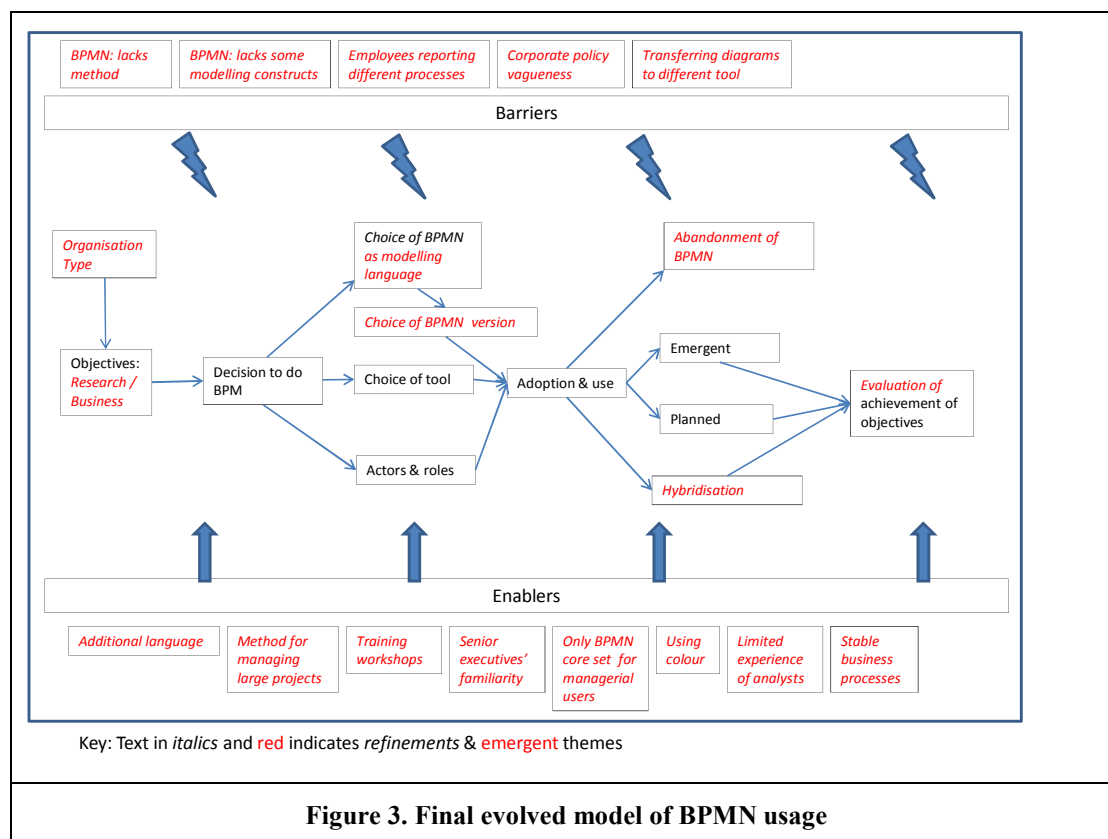
For the purposes of this example of a model-driven SLR, we decided to concentrate on those papers that provided case studies or experience reports which reflected on the use of BPMN in organizations. There were only 12 such usable papers. We discovered that some papers which claimed in their Abstracts or Introductions to provide case studies stated that the authors had developed a system for an organization using BPMN and provided extracts from their models, but did not reflect on the use of BPMN. Other papers claiming to offer a case study merely used processes from a real-life organization as examples to illustrate one or more BPMN models. They gave no detail of the organizational context, and often the processes were simplified to aid comprehension and readability. Generally such papers' focus was on demonstrating extensions to BPMN or tools to support BPMN, not the use of BPMN in an organization, so they were excluded from our synthesis. Because there were few empirical organization-based studies, we set the barrier for inclusion low and included those which gave only limited coverage (e.g. a few

paragraphs) of primary research or reflections on BPMN. Stage 5 of the method uses the quality of the data as the key determinant for inclusion: this should be explicitly defined and recorded even where, as in our study, the threshold is set very low.

Table 2. Analyzed papers containing empirical organizational BPMN data	
Paper	**Found in:**
Auer et al, 2009	CSDL
Bastide et al, 2010	Inspec
Bhuiyan and Krishna, 2010	AISeL
de la Vara and Sanchez, 2009	Inspec
de la Vara et al, 2008	Inspec
Green et al, 2005	AISeL
Hernandez et al, 2010	Inspec
Hinge et al, 2010	Inspec
Linna et al, 2009	IEEE Xplore, inspec
Overhage and Birkmeier, 2009	AISeL
Patig and Casanova-Brito, 2011	AISeL
Recker and Dreiling, 2011	AISeL
Recker et al, 2006	AISeL
Recker et al, 2010	Business Source Elite, ingenta
Recker, 2010	Inspec, ingentaconnect, Emerald
Siegeris and Grasl, 2008	Inspec
Simmonds and Collins, 2010	AISeL
Svagård and Farshchian, 2009	Inspec
Zhu et al, 2008	Inspec
zur Muehlen and Ho 2008	IEEE Xplore, inspec, CSDL

Our initial model was shown in Figure 2 (above). The evolved model (Figure 3, below), is a high-level synthesis of the factors we found that could influence the effective use of BPMN in organizations. In this section we provide a textual commentary which supplements this model and explains the gradual development of the evolved model from our reading of the empirical papers. The papers discussed in this section are given in the same chronological order that they were studied. This narrative summarizes the significant content of the papers, and "tells the story" of our emergent interpretation of the data found in them as we cycled between individual papers and the emerging model. We also start to populate the model by giving details about its elements, e.g. the different types of organizations in which BPMN has been used, which could be of interest to practitioners considering adopting BPMN. Table 3 (below) summarizes the location of evidence used to reflect on and refine the initial model, resulting in the evolved model as shown in Figure 3.

Siegeris and Grasl (2008) report their use of BPMN in "gematik, a German public-private partnership" developing a German health insurance chip card. This organization was undergoing business transformation with a new matrix organizational structure, and believed BPM would enable it to "establish clear responsibilities and defined workflows to ensure efficient definition of high-quality specifications at reasonable cost." BPMN was chosen because it was standardized by the OMG, supported by a wide variety of tools, and its models could be used for simulation and automated process execution.

| BPMN: lacks method | BPMN: lacks some modelling constructs | Employees reporting different processes | Corporate policy vagueness | Transferring diagrams to different tool |

Figure 3. Final evolved model of BPMN usage

These author assertions can readily be confirmed. A further reason was because, the authors assert, BPMN is readily understood by both IT users and business users. The experience report explains how BPMN had to be extended with language constructs based on UML in order to capture high-level process architectures, organizational structures and detailed data and information models. It was also found that the large set of BPMN process models were not readily understood by other organizational members. To overcome this, an Intranet-based process portal was developed, so that users clicked on a process, role or artifact to access the related process documentation. Because BPMN is a modeling notation and not a complete method, the BPMN team also had to design ways of organizing large scale modeling efforts with many modelers. They established a common set of modeling guidelines which were then used to train the modelers. In addition a wiki was used for questions and answers and tips, there were weekly meetings of all the modelers and an approval process was implemented to sign off all models. The project was still ongoing so it is not known if the business transformation objective was achieved. Little information is given about the authors; one works for gematik, the other appears to be a management consultant. They do not report the views or reactions of any other team members or stakeholders. Nevertheless, the paper was useful as it helped us populate our initial model with information about the limitations of BPMN and how they can be overcome (barrier: lacks associated method; enablers: additional modeling language, appropriate method for managing large projects), and the study offers some reasons for choosing to model business processes via BPMN. The use of BPMN to redesign a service management system in a USA truck service business is reported by zur Muehlen and Ho (2008). An as-is process model was created from scratch, before a to-be model could be produced to improve efficiency and remove bottlenecks. BPMN was selected because a standardized notation would enable inter-organizational collaboration along the supply chain and help the consolidation of internal company processes, and tool support was available. Two BPMN workshops were held for the key stakeholders, and the authors write that the senior executives' familiarity with process mapping was significant in the project's success. No evidence is given to support this assertion, but it did suggest a possible enabler in our model. A further enabler was the use of a limited set of BPMN constructs (BPMN's core set) in models to be considered by the organization's employees. Potential barriers experienced by the authors were corporate policy

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vagueness and different people reporting different process structures. The to-be system was simulated over a 30 day period and showed time savings which equated to savings of $100k per month. Again little information is given about the researchers and their role, and the viewpoints of the employees and stakeholders are not discussed, but the study helped us further refine the model, with detail about the purpose for using BPMN, the outcome, and enablers and barriers (enablers: training workshops, senior executives' familiarity, BPMN core set only; barriers: corporate policy vagueness and employees reporting different process structures).

Table 3. Evidence of model elements detected in the analyzed papers											
Element	Objective	Achievement of Objective	Decision to do BPM	Choice of BPMN method	Choice of tool	Actors and Roles	Adoption and use	Planned approach	Emergent approach	Enablers	Barriers
Paper											
Auer et al 2009	✓	✗	✓	✓	✓	✓	✓	✗	✗	✓	✓
Bastide et al 2010	✓	✗	✓	✗	✗	✓	✓	✓	✗	✓	✗
Bhuiyan and Krishna 2010	✓	✗	✓	✓	✗	✗	✓	✓	✗	✓	✓
de la Vara and Sanchez 2009	✓	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓
de la Vara et al 2008	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓
Hernandez et al 2010	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗
Hinge et al 2010	✓	✗	✓	✗	✓	✗	✓	✗	✗	✗	✗
Linna et al 2009	✓	✓	✓	✓	✗	✓	✓	✗	✗	✓	✓
Siegeris and Grasl 2008	✓	✗	✓	✓	✓	✓	✗	✗	✓	✓	✓
Svagård and Farshchian 2009	✓	✗	✓	✓	✗	✓	✗	✗	✓	✓	✓
Zhu et al 2008	✓	✓	✓	✓	✗	✗	✗	✓	✓	✓	✓
zur Muehlen and Ho 2008	✓	✓	✓	✗	✓	✗	✓	✓	✓	✓	✓

An ongoing study is reported by Svagård and Farshchian (2009): a multi-national European project to improve the quality of care of chronically ill patients and reduce costs by improving collaboration and optimizing work sharing between primary and secondary care services. Business Process Modeling was chosen to enable greater organizational efficiency because, the authors assert, it enables the externalization of internal knowledge, which can in turn lead to process automation. BPMN was chosen because, the authors assert, it can capture complex business processes in a simple way with the use of a few standard symbols. The team members augment BPMN by using color for different kinds of care providers – which highlight interaction points and show where member countries provide different kinds of care differently. Again little information is given about the authors, who are members of the development team, and no voice is given to the other team members or stakeholders. But the experience report helped us develop our model with possible reasons for business process modeling and BPMN, and the use of color to make BPMN models more useful (an enabler).

Zhu et al (2008) provide an experience report of another ongoing initiative: a project for an Australian industry-standardization body supporting the financial lending sector. Business process modeling should produce industry-wide business process reference models (standard processes and best practice), in order to improve coordination and efficiency across the sector. The authors state that BPMN was chosen because it is the generally accepted standard process definition language and it has abundant tool support. However, they found some important limitations in BPMN so that it could not adequately model their business processes (barrier: lacks some modeling constructs). It lacked adequate means to capture resource management, including allocation policies and when and where process performers can act autonomously. It also could not model exception handling where exception handling could be dynamically determined by context, rather than being predefined. It also could not sufficiently capture process variability between different organizations, nor support the cross referencing of control flows with data flows. To overcome these problems they used a different modeling language, Little-JIL (Wise 2006). The authors intend to continue using BPMN for "some aspects of the process definition", but unfortunately they do not make clear when or where. Nevertheless, their paper suggested another modification to our initial model: it currently shows "Planned use of BPMN" and "Emergent use of BPMN", but we realized we may also need a third element: "Abandonment of BPMN" – whether because of limitations in the notation, as reported here, or because of organizational or other social factors. Also, the difficulties they report may be related to the application domain, an industry-wide initiative, where many different organizations have developed their own business processes, and the model has to capture the variety and not simply impose one standard way of working. This suggested a new element for our model: the type of organization where BPMN is applied may influence its effective use. Again no information is given about the authors and the rest of the project team, and no voice is given to the other team members or stakeholders.

As our synthesis developed, we found each new experience report repeated elements of earlier reports we had studied, but could still suggest some further refinements to our emerging model.

Bhuiyan and Krishna (2010) report using BPMN in a large public department in Australia concerned with education. The team used BPMN to model and communicate process characteristics to the relevant stakeholders, in combination with the agent-oriented conceptual modeling of i* to capture the high-level organizational context and actors and roles, and UML to build use cases and test cases for automation – "additional modeling languages" as enablers in our emerging model. Once more, no information is provided about the authors and the other team members, and no voice is given to the other participants.

De la Vera et al (2008; 2009) wanted to test their approach to requirements analysis based on BPMN for business process modeling plus the "goal/strategy Map approach" (Rolland 2007) to capture the intentions (goals) of the organization– again "additional modeling language" in our emerging model. The approach was used within a software development company in Spain, as well as three of its client organizations, but no further information is given about any of the organizations involved. Reading this paper alerted us to the need to divide "Objective" in our analysis and emerging model into "Researcher objectives" and "Organization objectives". The authors assert (with no evidence) that the combined approach of BPMN plus Map was successful. Interestingly they write that senior analysts thought the approach was unlikely to offer them productivity gains so they would be unlikely to re-use it, whereas junior analysts thought they would experience productivity gains and would reuse it. We added "limited experience of analysts" as a potential enabler in our model.

Auer et al (2009) report on work with a software development company, where BPMN was used because the company felt it enabled business analysts to design processes and developers could add necessary technical details later. The authors argue that BPMN needs to be integrated with user interaction and data modeling, and the bulk of the paper describes how they extended BPMN using Formcharts and a UML data model (enabler: additional modeling languages). They claim that this helped (i) eliminate system documentation inconsistencies and (ii) customers become familiar with the intended system's user interface. There is no data to back up these claims, and no voice other than the authors'.

Bastide et al (2010) report on an ongoing French project to develop an information system to manage the care of elderly people in their own homes. This system is being modeled with BPMN. However, the only BPMN-specific reflection is that they believe it provides a good notation for modeling workflows of a collaborative process. Hernandez et al (2010) use some BPMN in a "Use Process Diagram" combined with Use Case Diagrams of UML (additional modeling language). This hybrid technique has been trialed in

three small projects in two organizations (a department of the Mexican government and a private software development company). They assert that the user interface designer, software architect, and programmers all found the diagrams easy to understand, but give no feedback from the business users. Linna et al (2009) mentioned use of BPMN version 1.1 to investigate whether it can capture the processes of an emergency response centre in Finland. This alerted us that the version of BPMN used could influence its effective use, and our model was modified. They used interviews with managers to help them produce the models, but give no research method details or primary data. They assert that BPMN is useful, enabled by stable business processes, but barriers include the difficulty in describing timelines (BPMN explains workflow well but not duration - lacks some modeling constructs) and the difficulty of transporting diagrams from one software tool to another (barrier). Finally a novel domain for BPMN is described by Hinge et al (2010): care flow management, in particular to capture clinical protocols and detect treatment conflicts when a cancer patient is also undergoing other treatment. They augment BPMN with Controlled Natural Language (Schwitter and Fuchs 1996) so that semantic effect descriptions can be added to the process models - again the enabler is an additional modeling language. They report that they have used this approach to model twelve cancer trial protocols, but unfortunately no further discussion is given of BPMN in use.

Only the abstract was available for Overhage and Birkmeier (2009), and Simmonds and Collins (2010) describe only some planned empirical research. The remainder of the empirical studies used surveys via interview or questionnaire (Green et al 2005; Patig and Casanova-Brito 2011; Recker 2010; Recker & Dreiling 2011; Recker et al 2006; Recker et al 2010). Such studies give limited information about specific organizations and cannot provide the richness of case studies or experience reports. Given paper length restrictions we have not included them in our synthesis here, but we intend to examine their findings and incorporate them if appropriate into our emerging model in a longer paper.

Our model-driven SLR led to our final evolved model (Figure 3), where barriers and enablers elicited from the literature have been added to the model (summarized in Table 4, below).

In the iterative process of analysing, synthesizing and modeling, the three authors had to reach a shared interpretation of each element of the model, leading to rewording of two elements of the model for clarification: "Choice of BPMN as modeling language", and "Evaluation of achievement of objectives". It is also striking that many of the papers report the augmentation of BPMN with other modeling languages (e.g. Auer at al 2009; Bastide et al 2010). This may be because of BPMN limitations, but may simply reflect those authors' interests. We decided such frequent "Hybridization" of BPMN warranted an additional element in our model.

In conclusion to our example model-driven SLR: our final evolved model shows factors which could influence the effective organizational use of BPMN. The model's origins and evolution are documented and amplified by the textual commentary in this section. However, the model is derived from only 12 empirical studies, and the strength of evidence is currently low for all elements of the model. The model is evolutionary and will evolve again in further hermeneutic cycles, as the papers we found are re-interpreted by ourselves or others, as the survey-based studies, classroom-based studies and the grey and practitioner literature are incorporated, as more empirical studies are undertaken, and as BPMN itself evolves.

The model will be of use to researchers working in business process modeling or reengineering, and IS requirements determination more generally. It indicates elements that researchers could investigate further and, as more empirical research is undertaken, future SLRs could concentrate on just parts of the model. Practitioners will find the model useful if they are engaged in a business process modeling project where BPMN might be used. However, our study found that the academic research evidence is limited; most researchers focus on the development of new BPMN notation and tools and theoretical concerns over ontological completeness and clarity. So far therefore, there is little empirical research to inform practitioner decision-making about BPMN.

Table 4. Mapping of barriers, enablers and new/revised model elements to analyzed papers	
Barriers	**Papers**
Corporate policy vagueness	zur Muehlen and Ho 2008
Employees reporting different processes	zur Muehlen and Ho 2008
Lacks associated method	Siegeris and Grasl 2008
Lacks some modeling constructs	Linna et al 2009; Zhu et al 2008
Transferring diagrams to different tool	Linna et al 2009
Enablers	**Papers**
Additional modeling language	Auer et al 2009; Bhuiyan and Krishna 2010; de la Vara and Sanchez 2009; de la Vara et al 2008, Hernandez et al 2010; Hinge et al 2010; Siegeris and Grasl 2008
Appropriate method for managing large projects;	Siegeris and Grasl 2008
Limited experience of analysts.	de la Vara and Sanchez 2009; de la Vara et al 2008
Only BPMN core set for managerial users.	zur Muehlen and Ho 2008
Senior executives' familiarity	zur Muehlen and Ho 2008
Training workshops	zur Muehlen and Ho 2008
Use of color	Svagård and Farshchian 2009
New/Revised Elements	**Papers**
Abandonment of BPMN	Zhu et al 2008
Choice of BPMN *as modelling language*	*From author's emerging shared meaning*
Choice of BPMN Version	Linna et al 2009
Evaluation of achievement of objectives	*From authors' emerging shared meaning*
Hybridization	Auer et al 2009; Bhuiyan and Krishna 2010; de la Vara and Sanchez 2009; de la Vara et al 2008; Hernandez et al 2010; Hinge et al 2010; Linna et al 2009; Siegeris and Grasl 2008
Objectives: *research and business*	de la Vara and Sanchez 2009; de la Vara et al 2008
Organization type	Zhu et al 2008

Reflections on the Model-driven SLR Method

The method begins in Stage 1 with an initial tentative model (or "soft" hypothesis/set of propositions) about how a change or intervention might be effective. This initial conceptual model, which in our case was inductively derived from the authors' practical experience, is intended to be a structuring and/or learning device (Pidd 2004) to drive the analysis and synthesis of the empirical literature, which, in turn, populates, refines and possibly even contradicts the initial model. Pawson (2006) mostly uses the term "theory" instead of "model", but he does sometimes inter-change it with "model", for example: "Primary research is examined for its contribution to the developing theory. The overall intention is to create an abstract model of how and why programmes [changes, or interventions] work, which can then be used to provide advice on the implementation and targeting of any novel incarnation of the intervention." (Pawson 2006, p 74). We prefer to use "model", to avoid confusion with the way "theory" is commonly understood in IS.

In the example SLR described above, our initial model was based on our combined previous experiences.

We could also have developed an initial model from a preliminary quick study of the existing literature, or we could have adopted a pre-existing model about the use of business process modeling in organizations. None of these approaches is superior; the selection will depend on the problem context (Pidd 2004; Webster and Watson 2002). The aim is to make an informed judgment based on the available data and researcher experience and then develop the model as a starting point. It then shapes and drives the analysis and synthesis of primary research studies, and the empirical research findings of these studies enable us to refine and correct the model. We have shown how this process of refinement and evolution can occur through our textual commentary on our interpretation of the BPMN papers that we found.

This model-driven, interpretive approach is based on a hermeneutic cycle where the three authors gradually developed a shared understanding and synthesis of previous empirical studies. A limitation we observed is the time required to develop such a shared interpretation – a single researcher is possible and would be quicker, but would have no one to challenge their interpretation of previous studies.

We also noted the lengthy narrative required to explain to readers how the model evolved. Conventional SLRs for EBP that extract quantitative data from previous studies and use statistical meta-analysis, aided by software, to synthesize the data, can be much more concise but then sometimes lack the rich contextual evidence essential for understanding and developing solutions to complex socio-technical research problems. However, the problem of lengthy narratives is experienced by many qualitative researchers; long textual analyses are the inevitable consequence of qualitative data analysis.

Questions might also be posed about the rigor and validity of the underlying model, the subjective nature of our interpretive mapping of study findings to the model, and the generalizability of the model. These (positivism-based) questions often faced by qualitative, interpretive researchers. It is now recognised that credibility and plausibility are more appropriate evaluation criteria for qualitative research, and we shall investigate further how these can be successfully demonstrated when following this model-driven SLR method. Ultimately an evolved model's usefulness depends on whether practitioners find the model helpful in informing decisions about an IS change in their own particular contexts, and whether IS researchers choose to build upon and refine the model further, as more empirical studies are conducted. A future research goal might also be to develop models that exhibit some aspects of good theory as identified from Webster and Watson's (2002) review of leading theoreticians: in summary they should be memorable and provide answers to why; they should explain, predict and delight; they should be interesting yet parsimonious, falsifiable and useful; they should be built from multiple paradigms; and they should exhibit creativity, relevance and comprehensiveness.

Conclusion

Our main contribution is an explanation and demonstration of the use of a model-driven method for SLRs, within the context of EBP, using Oates' (2011) eight stages and the example of BPMN in use in organizations. This method is aimed at the analysis and synthesis of qualitative research studies, to inform practitioner decision-making and support EBP, and also, possibly, to stimulate further empirical research. The initial model (Figure 2) was developed using an inductive process. It then evolved and drove a highly focused SLR. Empirical studies within organizations were analyzed for data pertinent to parts of the emerging synthesized model and findings from our joint interpretations were mapped back onto the model. The result is our final evolved model, Figure 3. The evidence for the model can be traced back to the original studies and the initial tentative model of the researchers via our textual commentary. Instead of answering the simplistic question of a conventional SLR, "Does BPMN work?", we have demonstrated the more nuanced, model-driven approach proposed by Oates (2011) to show what factors influence the effective use of BPMN in organizations, based on the (limited) available evidence. Our study can serve as an exemplar for other model-driven SLRs.

We do feel that this model-driven method for SLRs of qualitative data merits further exploration and development. For example, we shall explore its similarities with the grounded theory method in helping us to develop theories about IS, and compare it with other synthesis methods for qualitative research, such as "inductive thematic analysis" (Lencucha et al 2010). In a further paper we shall also reflect more on our subjective experiences as a distributed team following this model-driven method for SLRs.

We believe that the EBP paradigm offers great potential for the development of a cumulative knowledgebase in IS, and for IS research to be made more useful and relevant for practitioners. We urge

researchers reporting on case studies to give rich detail about the organizational context and participants' viewpoints. The model-driven method for SLRs discussed and illustrated in this paper suggests how such qualitative empirical studies might then be analyzed and synthesized in a transparent way, in order to produce useful evidence for the decision-making processes of practitioners.

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