Requirements Elicitation Using BPM Notations: Focusing on the Strategic Level Representation

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Abstract: - Business process models (BPM) can be useful for requirements elicitation, among other uses. Since the active participation of all stakeholders is a key factor for successful requirements engineering, it is important that BPM be shared by all stakeholders. Unfortunately, organizations may end up with inconsistent BPM not covering all stakeholders' needs and constraints. The use of multiple levels of abstraction (MLA), such as at the strategic, tactical and operational levels, is often used in various process-oriented initiatives to facilitate the consolidation of various stakeholders' needs and constraints. This article surveys the use of MLA in recent BPM research publications and reports on a BPM action-research case study conducted in a Canadian organization, with the aim of exploring the usefulness of the strategic level.

Key-Words: - Business process modeling, levels of abstraction, requirements elicitation, case study, action research

1 Introduction

Business process models (BPM) were designed to help document, communicate, or improve organization's business processes. BPM are also used for requirements elicitation as part of software engineering processes [1].

Software development is dependent on the quality of the requirements elicitation activities [2] and it is crucial that the business processes be adequately modeled.

One key factor reported for obtaining a high quality BPM is the active participation of all the stakeholders that ensures the development of a shared vision of the business processes [2, 3]. Unfortunately, literature shows that, in practice, organizations face various difficulties for achieving this state: a lack of truly cross-departmental BPM initiatives [4]; a lack of consensus on the BPM notations [1, 5]; and the growing complexity of these notations [6]. Despite the efforts to overcome these difficulties, it is reported that the most popular BPM notations still lack the constructs to be easily used as a means for requirements elicitation in software engineering [1].

It is observed that difficulties to facilitate the active participation of all stakeholders create inefficiencies and duplications, resulting in numerous communication problems, causing rework, software engineering project delays, costs overruns, and projects failure.

Initially, BPM comes from management which has the intention of increasing competitiveness of the organizations [7, 8]. Since business processes have been automated in information systems, then both: management and IT stakeholders must be considered if a BPM initiative is to be successful. Each group of stakeholders has its own particular modeling needs and constraints. To solve these issues many authors [5, 9-12] have argued that BPM at multiple levels of abstraction (MLA) helps to represent the information to be provided to various types of stakeholders.

The most popular approach for classifying managerial activities is presented by Anthony's

model [13, 14], which defines three levels of abstractions: strategic, tactical, and operational. The strategic level covers the activities related to the goals, objectives and policies of the organization. The tactical level deals with the attainment and efficient use of the resources of the organization. Finally, the operational level procures the efficient and effective execution of the specific tasks.

Using Anthony's model as a basis to ensure that management and IT perspectives of a business process can be shared easily, a BPM approach has been proposed in Monsalve et al. [1]. This proposal showed that it is possible to identify the modeling constructs for a specific perspective based on a representational analysis [15] and a MLA analysis.

This paper: 1) surveys the use of MLA in recent BPM research; and 2) explores how the strategic level, of Anthony's model, can be modeled and shared by both IT and management. To demonstrate the potential of the technique a case study in a Canadian software development company is presented. As a consequence, this paper aims at: 1) presenting a BPM approach, based on MLA, that could allow management and IT stakeholders to share a common vision of a business process; 2) empirically testing the proposed BPM approach; and 3) reporting the participants perceptions on the BPM notations that were selected for the case study (i.e.: Qualigram [9] and BPMN [16]).

The structure of this paper is as follows. Section 2 presents a survey of the use of MLA in recent BPM publications. Section 3 describes the methodology used to conduct the case study. Section 4 reports the results of the case study. Finally, section 5 reviews the contributions of this research, its limitations and future work.

2 MLA in BPM Research Publications

This section surveys the use of MLA in selected BPM research proposals. All the proposals recommend BPM at three levels of abstraction (see Table 1). However, depending on the author, the content of each abstraction level varies from one proposal to another. Additionally, we identify those research propositions that have empirically tested their proposals using real case studies where participants are present both in IT and in management. Let's look at our findings.

Table 1 shows first the three levels of abstraction proposed by Bhat and Deshmukh [12] which is similar to Anthony's model hierarchy. However, the top level (i.e. business process level) does not address the goals and objectives of the organization. We note also that this proposal has not been empirically tested. A second proposal studied, from Haque, Pawar and Barson [10], also proposes a similar approach to the three levels of Anthony's model. However their proposal is completely management-oriented and the top level is not process-oriented. We then studied Lin, Yang and Pai [17] proposal of a BPM method. However, their top level (i.e. gross grained) does not match the strategic level of Anthony's model. We also observed that their proposal has not been empirically tested. We then studied Gulla and Brasethvik [11] proposal. However, their "functional" level of abstraction is completely oriented to the implementation of an Enterprise Resource Planning (ERP) system. Finally, the last proposal we studied, comes from Dreiling et al. [5]. It follows an approach scarcely related to Anthony's model. The lowest level of abstraction (i.e. technical

Table 1 MLA in BPM research

Bhat & Deshmukh	Level	Business processes	Process workflow	Business procedures
	Content	Core processes	Workflow and sub processes	Procedures, tasks, system info, details
Haque, Pawar & Barson	Level	Level 3. Company strategy	Level 2. Functional & Process phase	Level 1. Operating team
	Content	Strategy, goals.	High level business processes, functions.	Details of organization &providers processes.
Lin, Yan and Pai	Level	Gross grained	Medium grained	Fine grained
	Content	Supply chain network	Core processes	Functionality of each process
Gulla & Brasethvik	Level	Business	Workflow	Functional
	Content	Goals, strategy	Workflow, roles, tools, resources	ERP point of view of business processes
Dreiling, Rosemann, van der Aalst & Sadiq	Level	Management	Business analyst	Technical
	Content	High level business processes, inter-relations	Rich detail (workflow), some rigor, intuitive notation	Information required for the implementation of the systems

level) is completely IT-oriented. We also note that this approach has not been empirically tested.

In conclusion, despite the fact that the publications investigated in this research recommend BPM at three levels of abstraction, their proposals not always match the three levels of Anthony's model. Moreover, most of the publications investigated neither considers an active collaboration of management and IT stakeholders, nor develops their BPM approaches considering various potential uses of the BPM generated. Additionally, the publications investigated rarely test empirically their proposals with both types of participants: IT and management. Addressing these issues has motivated the BPM approach proposed in this research and testing it with a case study conducted in a Canadian company.

3 Case Study

This paper reports the results of a case study conducted at a Canadian company for testing the usefulness of the strategic level. The empirical research follows an action research methodology [18] to conduct the case study. Two members of the research team collaborated in a BPM activity with members of the participant company. The action research methodology aims at acquiring new knowledge but providing, at the same time, value to the participant organization [19]. This approach has been extensively used for information systems research [18, 20], and it is considered a valid case study methodology for empirical software engineering research [19, 21].

We follow the guidelines proposed by Runeson and Höst [21] for "reporting case study research in software engineering".

3.1 Framework: the BPM approach

The BPM approach proposed in this paper does not only aim at representing the information required for the development of software applications that execute business processes, but it also aims at representing information considered as critical by management stakeholders such as: goals, objectives, strategic third party stakeholders, etc.

The approach proposed includes three levels of abstraction (i.e. strategic, tactical and operational). The top level of abstraction (i.e. strategic level) should serve to communicate the goals of the organization, and to depict the core business processes and their main relationships. It should also represent the external stakeholders that are relevant to the organization. The intermediate level of abstraction (i.e. tactical level) should describe the flow of activities of the business processes; depicting how the various roles and departments of the organization interact, as well as the resources required for the execution of the activities. The lowest level of abstraction (i.e. operational level) is very challenging. It could present multiplicity of forms depending on the specific needs of each stakeholder at the operational level. For instance, if the stakeholder is dealing with the implementation of software applications, then all the additional information required to develop the application should be modeled with the required rigor at this level. On the other hand, if the stakeholder is responsible of BPM to comply with an external regulation, then the critical activities for each business process, their control criteria and corrective actions should be modeled at this level [22].

3.2 BPM notations selected

Several BPM notations have been investigated as part of this research. Two of them have been selected for testing the BPM approach proposed: Qualigram [9] and BPMN (Business Process Modeling Notation) [16].

3.2.1 Qualigram

The Qualigram notation is selected because: 1) it presents a management-oriented focus; 2) it apparently matches with the MLA approach to be tested; and 3) its modeling tool is based on Microsoft's Visio. which has been identified as the preferred tool for BPM [4, 23].

The Qualigram notation proposes three levels of abstraction similar to the approach taken in Anthony's model. Berger and Guillard [9] argue that the Qualigram notation was designed to satisfy the requirements of the International Organization for Standardization (ISO) 9001 standards for describing business processes [24].

Qualigram's top level of abstraction models at a high-level the business processes and its main objectives, aiming at representing "why" the organization needs to perform the business process modeled. The intermediate level of abstraction models the procedures, aiming at representing "who" and "what" is done in the organization. Finally, the lowest level of abstraction models work instructions, answering the questions "how" and "using what" can I perform a specific activity in the organization.

At the strategic level (i.e. top level of abstraction) Qualigram proposes four types of models that go from a "macroscopic model" (see Fig. 1), which is a general description of the
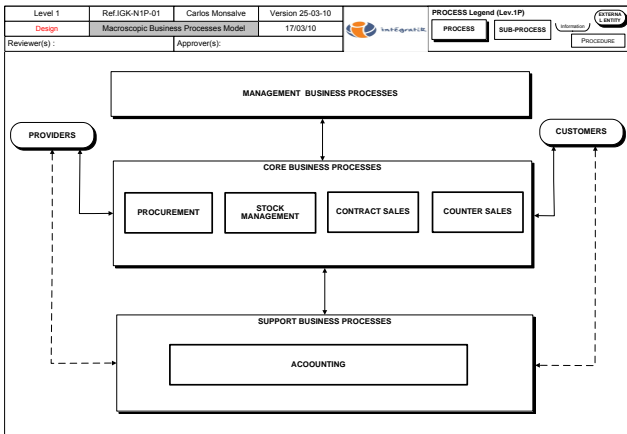
Fig. 1 Qualigram: macroscopic model

business processes, to a "detailed model" of each business process (see Fig. 2) showing the main sub-processes and their relationships. The case study tests the perceived value of each type of model.
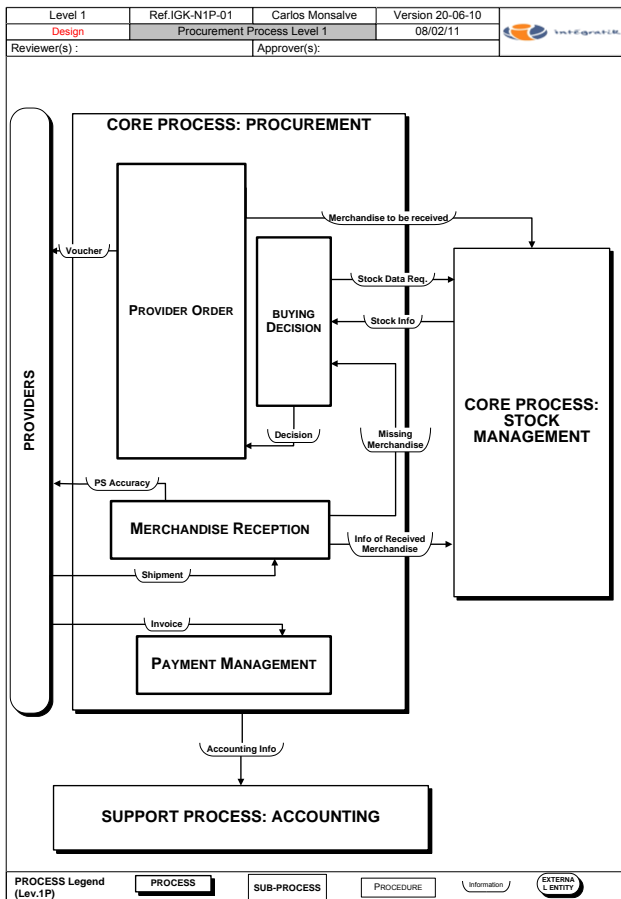

Fig. 2 Qualigram: example of detailed model

3.2.2 BPMN

BPMN has been selected because of its growing popularity and because of the considerable effort under way to establish it as a BPM standard. BPMN is rich in modeling constructs for representing various types of control flow and events. As a result,

BPMN has a high degree of expressiveness, but at the same time is highly complex [25]. There is a version 2.0 of BPMN [26], but it is still considered as a Beta 2 version at the time of the research; thus, BPMN version 1.2 was used for the case study.

BPMN does not present a three-layered approach as Anthony's model. However, BPMN was designed to provide a unified notation, both for IT and management stakeholders [16, 27]. For this purpose, BPMN includes a basic set of constructs called the "Business Process Diagram (BPD) Core Element Set" (Core Set), and a more complete set, "BPD Extended Set" (Extended Set) [16]. The former set is intended for documentation and communication purposes; the latter set for developing more detailed models appropriate for the analysis and automation of business processes.

To ease the interaction between management and IT, Silver [27] proposes to model with BPMN at three levels. The top level (i.e. Level 1) is a descriptive level intended for management users (see Fig. 3); it is based on the use of BPMN's Core Set and collapsed processes. The intermediate level (i.e. Level 2) is an analytical level intended to detail the events and exceptions of the business processes. Finally, the lowest level (i.e. Level 3) is an executable level intended to exploit the underlying XML characteristics of BPMN 2.0. The case study follows at the strategicl level Silver's Level 1 recommendations. This BPMN approach is meant to be compared with Qualigram's modeling approach.
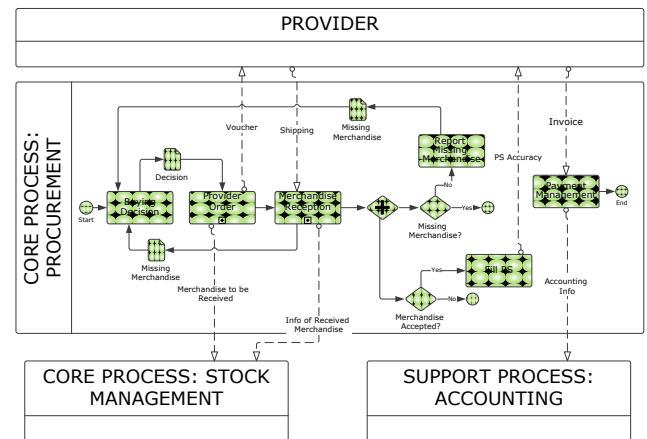

Fig. 3 BPMN: example at the descriptive level

3.3 Research design

This paper reports a case study conducted in a small software development company in Canada. The main product offered by the participant company is an ERP system. The participant company was selected for this case study due to: 1) their willingness to initiate a BPM initiative, 2) their

accessibility, and 3) their interest for the project. The company was willing to model the business processes supported or affected by the ERP in order to: 1) document them; 2) show the customers how the ERP interacts with the various end-users; and 3) communicate to their new employees the ERP functional characteristics.

The case study was planned for 4 months of work, and it required the participation of two members of the company. The first member is the owner and top-executive of the company. His participation ensures considering not only a technical perspective but also a commercial and organizational perspectives of the business processes. His participation is complemented with a member of the technical staff that supports the development of the ERP system. Neither of the two members had previous experience with BPM.

The BPM approach proposed was applied to a set of business processes that was selected by agreement with the participant company. The case study aims at evaluating not only the BPM approach, but also the selected BPM notations (both: their fitness to the approach and their perceived participant's acceptance). Therefore, the unit of analysis is the modeling of the business processes, including both the evaluation of the BPM approach, and the evaluation of each BPM notation.

The case study was conducted following the principles of canonical action research [20]: 1) a verbal agreement between the research team and the participant company is established; 2) a theoretical framework is used as a basis for the research process; 3) a iterative model governs the research process; 4) at each iteration the outcomes are analyzed to learn from them; and 5) actions are taken based on the interpretation of the outcomes.

3.4 Data collection and analysis
Evidence was collected through the analysis of: 1) existing archival data (i.e. ERP's documentation and ERP's reports); 2) interviews, discussions and feedbacks from the participants; and 3) observation both of the use of the ERP system and as an "observing participant". All relevant data was [21] transcript and maintained. The members of the company were allowed to review the transcripts and were iteratively informed of the findings. The data collection and its analysis were iterative. The knowledge that emerged after each iteration was documented. Insights from the theoretical framework were used to contribute to the analysis of the data and its interpretation for further iterations.

3.5 Threats to validity

Four main threats to validity are identified: 1) construct validity; 2) internal validity; 3) external validity; and 4) reliability [21]. Construct validity was improved using multiple sources of evidence and having the members of the company informed of the findings. Internal validity was improved both by having two researchers working in parallel and by addressing various rival explanations suggested by the various participants of the case study. External validity was improved using the theoretical framework both as a basis for the research and for data analysis and interpretation. Finally, reliability was improved by elaborating a research protocol.

4 Results

4.1 General results
The methodology used for this research showed to be adequate for empirically testing the BPM approach. However, it results critical for the success of this type of methodology the collaboration of the leader of the participant organization.

The MLA approach proposed was well accepted by the members of the company. They considered relevant to have various levels of abstraction in order to reach various types of stakeholders. Moreover, they indicated that the MLA approach eases using the BPM at various types of activities both inside the organization and with their customers.

The members of the company identified the value of the strategic level as the ability to expose their customers and their new employees to the business processes supported by the ERP system.

4.2 Qualigram
From the four types of models (i.e. macroscopic, relational, detailed and transversal) that Qualigram offers at the strategic level, it was decided to only use the macroscopic and the detailed types of models. The relational type of model was discarded because the members of the company considered that it does not add relevant information to the information provided by the macroscopic and detailed models. The transversal type of model was discarded because there was a consensus that its notation conflicts with the notation of the models to be generated at the tactical level.

The macroscopic type of model (see Fig. 1) was considered relevant because it: 1) identifies the main third-party stakeholders (i.e. customers and providers); 2) identifies the business processes that interact with the ERP; and 3) allows classifying the

business processes in a structured way (i.e. management processes, core processes, and support processes).

A detailed model was developed for each of the core business processes depicted in the macroscopic model. Due to limitations of space this article only presents the detailed model for the procurement business process (see Fig. 2). The detailed type of model was considered relevant because it provides: 1) a high-level model for each core process; and 2) a logical link between the macroscopic model and the tactical level models.

Qualigram's strategic level does not aim at representing any kind of workflow. However, the participant organization found it useful to always model as close as possible to the workflow of the business process. For instance, the detailed model showed in Fig. 2 does not present clear starting and ending events (typical of a workflow description); however the model is depicted trying to resemble the workflow of the procurement business process.

4.3 BPMN

BPMN does not provide a MLA approach similar to Anthony's model hierarchy. The closest BPMN's scenario to the strategic level is Silver's Level 1 type of model [27] (see Fig. 3). However, due to the fact that BPMN always requires modeling a workflow, it is impossible to generate a BPMN model with the characteristics of Qualigram's macroscopic model. Moreover, each core business process requires its own Level 1 model. Therefore, BPMN cannot represent a big picture of all the core business processes in a unique model.

The Level 1 type of model was considered relevant when modeling with BPMN because it provides a high-level model for each core process.

The modeling team tried to only use BPMN's Core Set plus the collapsed processes for BPM at the strategic level. However, it was impossible to stick to this norm. For instance, the model depicted in Fig. 3 makes use of a parallel fork (i.e. joint).

4.4 Comparison of BPM notations

The members of the company, who had no previous experience with BPM, found Qualigram notation easier to understand than BPMN. The research team experimented providing them various Qualigram models at the strategic level, and they were able to mostly interpret them correctly. The experience was quite different with BPMN due to the diversity of constructs used. The participant members mentioned that they would require training before starting a BPM initiative using BPMN. Therefore, Qualigram models were found to be more suitable for

introducing the business processes to customers and to new members of the staff.

The participant members found that BPMN is more rigorous than Qualigram for describing business processes. BPMN models were considered more precise and detailed than their Qualigram counterparts. Therefore, BPMN models were found to be more suitable as an input for the software development team.

5 Conclusions

Aiming at facilitating the participation of management and IT in a BPM initiative, this paper has presented a novel solution approach for BPM at MLA. The approach is based on the three levels of managerial activities found in an organization: strategic, tactical and operational levels.

The strategic level of the approach has been tested with a case study conducted at a Canadian software development company. The case study design, its potential weaknesses and the strategies used to overcome them have been presented.

The results of the case study have been reported. The MLA approach was well accepted by the participant company, and the perceived value of the strategic level has been identified. Two BPM notations: Qualigram and BPMN were compared, the former was found more suitable for customers, new employees, and management, while the latter was considered more suitable for the technical staff.

The results related to the other two abstraction levels (i.e. tactical and operational) will be reported in future publications. To improve the validity of the results another case study is under way.

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