BPM AND REQUIREMENTS ELICITATION AT MULTIPLE LEVELS OF ABSTRACTION: A REVIEW

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ABSTRACT

Business process (BP) models can be useful for requirements elicitation, among other uses. Software development is dependent on the quality of the requirements elicitation activities; therefore, it is critical to adequately model the BPs. One key factor for achieving this is the active participation of all the stakeholders and the development of a shared vision of the BPs. Unfortunately; organizations often end up with inconsistent BPs not covering all stakeholders' needs and constraints. The use of multiple levels of abstraction (MLA) may facilitate the consolidation of various stakeholders' requirements. This article contributes to the research of using MLA in business process modeling (BPM) for software requirements by reviewing the theoretical foundations of MLA and their use in various BP-oriented approaches.

KEYWORDS

Business process modeling, levels of abstraction, requirements elicitation, requirements modeling, review.

1. INTRODUCTION

Business process (BP) models were designed to help document, communicate, or improve organization's BPs as part of a business process management initiative. BP models are also used, by software engineers and business analysts, for requirements elicitation and analysis (Mayr et al., 2007, IIBA, 2009).

Software development is dependent on the quality of the requirements elicitation activities (Abran et al., 2004); therefore, it is critical that the BPs be adequately modeled. One key factor for a high quality BP model is the active participation of all the stakeholders to develop a shared vision of the BPs (Sedera et al., 2004, Becker et al., 2000). Unfortunately, literature shows that organizations face various difficulties for satisfying this key factor: a lack of truly cross-departmental business process modeling (BPM) initiatives; a lack of consensus on the BPM notations; and a growing complexity of these notations.

For instance, a recent study by Harmon (Harmon and Wolf, 2010) shows that only 23% of the times BPM projects are cross-departmental initiatives involving all stakeholders (i.e. most often they are departmental initiatives, led by either IT or management stakeholders).

Evidence also shows that different stakeholders are used to different notations, conventions and techniques to represent BPs (Monsalve et al., 2010). Some authors have reported on the difficulty of choosing a single BPM notation to allow effective communication between stakeholders (Monsalve et al., 2010, Dreiling et al., 2008).

Other authors refer to BPM notations as having become highly complex over the years in attempting to satisfy the multiple BP perspectives required by the stakeholders (Muehlen and Recker, 2008). Even then, the most popular BPM notations still lack the constructs to appropriately use BPM for requirements elicitation (Monsalve et al., 2010).

Difficulties to facilitate a shared vision of the BPs might create inefficiencies and duplications, resulting in numerous communication problems, causing rework, software engineering project delays, costs overruns and failure. Solutions to these difficulties have to provide the means for a consistent way of modeling various

BP perspectives. Ideally, the solution should be simple and should not significantly increase the complexity of BPM notations, thereby allowing BP models to be easily understood by various stakeholders.

A solution approach for identifying the modeling constructs for representing a specific BP perspective is proposed in Monsalve et al. (Monsalve et al., 2010). One of the pillars of this proposal is a multiple levels of abstraction (MLA) analysis. Based on this proposal, this article contributes to the research of using MLA in BPM by reviewing the theoretical foundations of MLA and their use in various BP-oriented approaches.

The structure of this article is as follows. Section 2 presents a review of the theoretical foundations of MLA. Section 3 describes the use of MLA in various BP-oriented approaches. Finally, section 4 concludes with a review of the contributions of this research, its limitations and future work.

2. THEORETICAL FOUNDATIONS

The origin of business process management comes from various recommendations that have been proposed to increase competitiveness of organizations, either by improving the quality of their products and services (Elzinga et al., 1995), or by improving the performance of their BPs (Zairi and Sinclair, 1995). Business process management is neither a technology nor a type of information system; it is a management approach. Smith and Fingar (Smith and Fingar, 2007) have pointed out that one reason why organizations were not doing business process management, is that it has been considered as an IT initiative.

BPM has been used for requirements elicitation by both: software engineers and business analysts. Each of these professions counts with a guide to its body of knowledge: the Software Engineering Body of Knowledge (SWEBOK) and the Business Analysis Body of Knowledge (BABOK) respectively. The SWEBOK (Abran et al., 2004) presents requirements elicitation as a complex activity which has to consider various stakeholders "at different levels of an organization". The BABOK (IIBA, 2009) also stresses the importance of considering all types of stakeholders; the various requirements should be represented in a consistent and structured way to guarantee their comprehension by all the stakeholders.

Therefore, the inclusion of management and IT stakeholders is a key factor for both: BPM, and requirements elicitation. Both groups of stakeholders must be considered when modeling BPs for requirements elicitation. Each type of stakeholders requires providing the means to represent in a consistent way its particular modeling needs.

Many authors (Dreiling et al., 2008, Berger and Guillard, 2000, Bhat and Deshmukh, 2005, Gulla and Brasethvik, 2000, Haque et al., 2003) have argued that the use of MLA helps to select the effective information to be provided to various types of stakeholders. The BABOK recommends the use of MLA to represent the various perspectives required by the stakeholders. The BP models should go from a "high level" model to a "low level" model depending on the targeted stakeholder (IIBA, 2009).

To keep the focus aimed; this review considers the various managerial activities of the organization. One long used approach for classifying the managerial activities is Anthony's model (Anthony, 1965, Gorry and Morton, 1971) which defines three levels of activities: strategic, tactical, and operational. The strategic level covers all those activities related to the goals and policies of the organization. Management activities deal with the attainment and efficient use of the resources. Operational activities procure the efficient and effective execution of specific tasks. Anthony's model has influenced both: the design of commercial BPM notations such as Qualigram (Berger and Guillard, 2000), and recent BPM research (Bhat and Deshmukh, 2005, Haque et al., 2003). Moreover, Berger and Guillard (Berger and Guillard, 2000) argue that the recommendations of the International Organization for Standardization (ISO) for documenting BPs reflect the three levels of activities found in organizations. It is possible to find organizational structures that do not follow the traditional organizational pyramid. Even then, it can be argued that organizations host stakeholders with various levels of information needs that respond to the various types of activities being performed at a specific moment of time.

3. MLA AND ITS USE IN BP-ORIENTED APPROACHES

The use of MLA is common for various BP-oriented approaches. This section reviews the use of MLA in: 1) process-oriented management approaches; 2) BPM notations; and 3) recent BPM research proposals:

3.1 MLA in management-oriented approaches

The use of MLA is common to several management-oriented BP approaches. This section reviews some of these approaches which to the authors' knowledge present a three-layered approach.

3.1.1 The Balanced Score Card

The Balanced Score Card (BSC) (Kaplan and Norton, 2007) defines four perspectives: financial, customer, internal process, and innovation/learning. The internal process perspective focuses on the core BPs of the organization; and it is represented by a three-layered structure (mission, objectives and measures).

Table 1. MLA in management approaches

Anthony's Model		**BSC Process Perspective**	**ISO 9000**	**SCOR Process Reference Model**	
Level	**Content**	**Content**	**Content**	**Level**	**Content**
Strategic	Goals, objectives	Mission	Quality Manual	Top level	Scope, types
Tactical	Resources	Objectives	Business Processes	Configuration level	Description and configuration of processes
Operational	Specific tasks	Measure	Support records	Process element level	Details of each process: inputs, outputs, information, metrics.

3.1.2 The ISO 9000 family of standards

The ISO 9000 family of standards (ISO, 2008, ISO, 2009) follows an approach that recommends three levels of documentation (quality manual, description of BPs, support records) that reflects the three levels of managerial activities (Berger and Guillard, 2000).

3.1.3 The Supply Chain Operations Reference model

The Supply Chain Operations Reference model (SCOR) (Council, 2008) proposes a process reference model with three levels of description: 1) The top level; 2) The configuration level; and 3) The process element level. The information to be represented at each level is depicted in Table 1.

Note in Table 1 that a management-oriented approach typically presents three layers of abstraction. Also, these approaches consider as important the inclusion of the customers and providers in the modeling of the BPs. Table 1 does not aim at showing inter-levels equivalences.

3.2 MLA in BPM notations

Several BPM notations have been investigated as part of this research. This paper only presents those notations that use levels of abstraction similar to the ones proposed in Anthony's model.

3.2.1 Qualigram language

Qualigram (Berger and Guillard, 2000) proposes three levels of abstraction (see Table 2). The top level (strategic level) models the processes, answering the questions "why" and "where to". The intermediate level organizational level) models the procedures, answering the questions "who" and "what". Finally, the lowest level (operational level) models the work instructions, answering the questions "how" and "using what".

3.2.2 The Architecture of Integrated information Systems

The Architecture of Integrated information Systems (ARIS) defines five enterprise perspectives; each of them presents three description levels: requirements definition, design specification, and implementation description. From a BPM point of view, ARIS works at three levels: 1) strategy level, 2) design, control and optimization level, and 3) execution level (Scheer et al., 2005, Davis, 2008). Additionally, ARIS suggests a BPM hierarchy composed of three abstraction levels: high level process, functions, and tasks (Davis, 2008).

Table 2 summarizes the reviewed modeling notations. Both notations use a three-layered approach. The table does not aim at showing inter-level equivalences.

Table 2. MLA in BPM notations

Anthony's Model		**Qualigram**		**ARIS**		
Level	**Content**	**Level**	**Content**	**Perspective views**	**BPM point of view**	**Process model hierarchy**
Strategic	Goals, objectives	Level 1. Process	Processes, sub-processes, objectives.	Requirements definition	Strategy level	High level processes
Tactical	Resources	Level 2. Procedure	Procedures, instructions, roles.	Design specification	Design, control and optimization level	Functions
Operational	Specific tasks	Level 3. Work instruction	Instructions, operations, tools, documents.	Implementation description	Execution level	Tasks

3.3 MLA in BPM research proposals

After reviewing the use of MLA in BPM notations, this section presents its use in selected BPM publications. The majority of the proposals found in the literature also recommend modeling business processes at three levels of abstraction (see Table 3). However, depending on the author, the content of each abstraction level varies from one proposal to another.

Bhat and Deshmukh (Bhat and Deshmukh, 2005) argue that to share a common vision of the BPs a hierarchy topped by a business process level representing the core processes of the organization is necessary. The hierarchy includes two additional levels (i.e. process workflow level and business procedure level) to include the individual requirements of the various stakeholders as it is depicted in Table 3.

Haque et al. (Haque et al., 2003) argue that experiences from both industry and academia have obtained better results when considering both organizational and technological issues rather than only considering the latter. They propose to model the BPs at three levels of abstraction as it is depicted in Table 3.

Lin et al. (Lin et al., 2002) analyze various BPM notations to find the "essential components" of BPM and. They propose a BPM method that uses three levels of abstraction as it is depicted in Table 3.

Table 2. MLA in BPM research proposals

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

Gulla and Brasethvik (Gulla and Brasethvik, 2000) propose three levels of abstraction (see Table 3). They conclude that "in practice, the process models are usually combinations of all these three [levels]".

Dreiling et al. (Dreiling et al., 2008) argue that if a BP model is generated for one specific purpose then it probably will not be reused for another purpose. They propose three levels of abstraction (see Table 3). The management-oriented level depicts the big picture of the BPs. The BA-oriented level aims at the communication between BAs and users. The technical-oriented level adds rigor to the models. Each level may use a different BPM notation. To integrate the various notations, a mapping at a meta-level is proposed.

Table 3 summarizes the reviewed research proposals. Table 3 does not aim at showing inter-level equivalences.

4. CONCLUSION AND FUTURE WORK

The SWEBOK and the BABOK stress the importance of considering requirements from all the stakeholders at the various levels of an organization. The BPM lessons learned suggest that any BPM initiative must consider both groups of stakeholders: management and IT. Despite the multiple efforts, the most popular BPM notations still lack the constructs to appropriately use BPM as a means for requirements elicitation. Recent studies evidence that organizations face difficulties to produce consistent and reusable BP models. The use of MLA opens new avenues for a consistent representation of BPs covering the needs and constraints of the stakeholders involved in a software project. The use of MLA is common to various BP oriented approaches, and it has also been recommended for BPM in recent research work.

All the approaches reviewed in this article share the use of three levels of abstraction. However, the characteristics of the levels vary from author to author. Those approaches that present a management orientation privilege the representation of the goals of the core BPs, their metrics, and the various activities, roles and resources involved in the BPs. Those approaches that present an IT orientation privilege the representation of the details of the BPs with a rigorous description of each workflow.

To aim at a unified BPM approach, the abstraction levels should procure the means to satisfy the modeling needs and constraints of each stakeholder in accordance with the type of managerial activity to be performed at a specific moment of time. Such an approach cannot aim at being only used as a means for deploying software applications, but also at facilitating the collaboration between the various stakeholders.

This article suggests using Anthony's model as a basis for the definition of each level of abstraction (i.e. strategic, tactical, and operational). The strategic level communicates the goals of the organization, and depicts the core BPs and their main relationships; it also depicts the external stakeholders that are relevant to the organization. The tactical level describes the activities of the BPs; depicting how the various roles and departments of the organization interact, and the resources required for each BP. This level also allows identifying, if it is considered necessary, the critical activities to achieve the goals of the organization. The operational level is very challenging. It could present multiplicity of forms that would depend on the specific needs of each stakeholder. For instance, if the stakeholder deals with the implementation of a software application, then all the additional information required to implement the application is modeled at this level in a rigorous way. On the other hand, if the stakeholder needs formalizing the BPs to comply with an external regulation, then the critical activities for each BP, their control criteria and their corrective actions are modeled at this level (Ouanouki and April, 2007).

The MLA approach proposed for BPM requires to be validated. Two case studies are under way to experiment the approach with two BPM notations: Qualigram and BPMN (OMG, 2009). Qualigram has been selected because it presents a management-oriented focus, and because the review shows a good match of its characteristics with the MLA foundations. The Business Process Modeling Notation (BPMN) has been selected because of its popularity and because of the effort under way to establish it as a BPM standard.

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