

Dissecting the Business Process Modelling fields: a concept maps approach

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Abstract. The multi-disciplinary nature of business process modelling with its different perspectives/views (business, organization, software and systems development,...) raised several objects/fields of study such as web services, languages, standards, business rules and architectures among others. In our approach we consider an environment (breeding environment) where a set of enterprises exist and maintain a set of social relationships, mainly trust relationships, that can be mobilised to join resources and collaborate to compete for a business opportunity. The definition of business processes, from a business point of view, implies a close articulation with the software systems components available to support parts of those processes. In this field of research there are many similar terms used in different contexts with different meanings, many different approaches whose intervention objects must be clearly identified as well as many descriptive and execution languages whose scope and goals must be well understood. The clarification of the business process modelling field is beneficial both for the business architects and for information systems architects. An approach based on the conceptualization domain, more specifically on the concept maps approach, is an effective way to achieve such a clarification. This work resulted in a conceptual map of the business process modelling field that enabled a critical analysis and the clarification of the relationships between business originated concepts and software systems ones.

1 Introduction

The heterogeneous, complex and continuously changing field of business networking (e.g. B2B, collaborative networks, etc.) raises several issues related with the management of Inter-Organizational Business Processes that satisfy a particular consumer's need: the establishment of shared visions and goals, process and activities coordination, resource allocation and distribution, information systems and information technology inter-operability, are examples of important issues addressed both by

research and practice. The articulation of business activities distributed over a set of organizations is an important research topic that has been addressed by various disciplines, in particular management and computer science. In the several phases in which IOBP management can be decomposed (definition, configuration, execution, maintenance) the modelling activities are of utmost importance.

Business Process Modelling is a well established research and practice field (though immersed in different research topics such as Enterprise Modelling or Information Systems Architectures, to name just two in opposite sides of the BPM spectrum), embraced in a first moment by the management and industrial communities and in a second moment by the computer science and information systems communities. Somewhere in between, we can identify the workflow management community. Business Process Modelling (BPM) is still an ongoing research topic. In fact, BPM is a research challenging issue specially focusing on the expression of interdependencies among business processes, information systems components and the emerging web technologies. The main objective of BPM is to provide a better understanding of how to express the business processes, their strategies and their behavior. Business models provide ways of expressing business processes or strategies in terms of business activities and collaborative behavior so we can better understand the business process and the participants in the process. Models are helpful for documenting, for comprehending complexity and for communicating complexity. Recently, BPM has gained a new breath pushed by the technological development in the area of internet/web technologies: web processes, service oriented architectures, semantic web. Although dealing with the same object of study - the organizational/business process - the terminology used by both communities can sometimes be confusing. This happens because of the use of the same terms referring to different concepts (different here is a continuum from "slightly" to "completely" different), or the use of different terms referring to the same concepts.

In this paper we undertake a conceptual analysis of the main fields dealing with BPM with the goal of clarifying conceptually the uses of BPM in the management and computer science fields. We intend to provide researchers and practitioners in these fields with a tool that helps them in understanding the BPM concepts and their relationships. Also an important goal (and the first aim of our work), is to set up a solid conceptual basis for interdisciplinary research in this area.

Section 2 will address briefly concept maps. Section 3 will provide a deep analysis of Business Process Modelling fields, describing the approach that we have followed to build the conceptual map, and presenting the obtained concept map as well as some concluding remarks. Section 4 enumerates the related work and Section 5 points out our future research and open issues.

2 Conceptual Mapping

Conceptual maps are an effective way of representing complex concepts and messages in a clear and understandable way. Conceptual maps are simple and practical

knowledge representation tools that allow the representation of knowledge in the form of a graph. The concepts are represented through boxes (nodes) and the relations between them are represented by lines (arcs) connecting the related boxes [5]. Conceptual maps are structured in a hierarchical way, where the most general concepts lie in the root of the tree and, as we descend the structure, we find the more specific ones. Concept maps have been demonstrated to be an effective means of representing and communicating knowledge.

Through a concept map we can identify the scope of the subject, the relative importance of information and ideas, and the way this information is related through the concepts in the conceptual map.

In many disciplines various forms of concept map are already used as formal knowledge representation systems, for example: semantic networks in artificial intelligence, bond graphs in mechanical and electrical engineering, CPM and PERT charts in operations research, Petri nets in communications, and category graphs in mathematics [6].

Concept Maps can also be used well to summarise information, to consolidate information from different research sources, to think through complex problems and as a way of presenting information that shows the overall structure of your subject. Concept Maps are also very quick to review - it is easy to refresh information in your mind just before it is needed by glancing at one [6].

3 Mapping the BPM Fields

3.1 Conceptual Analysis

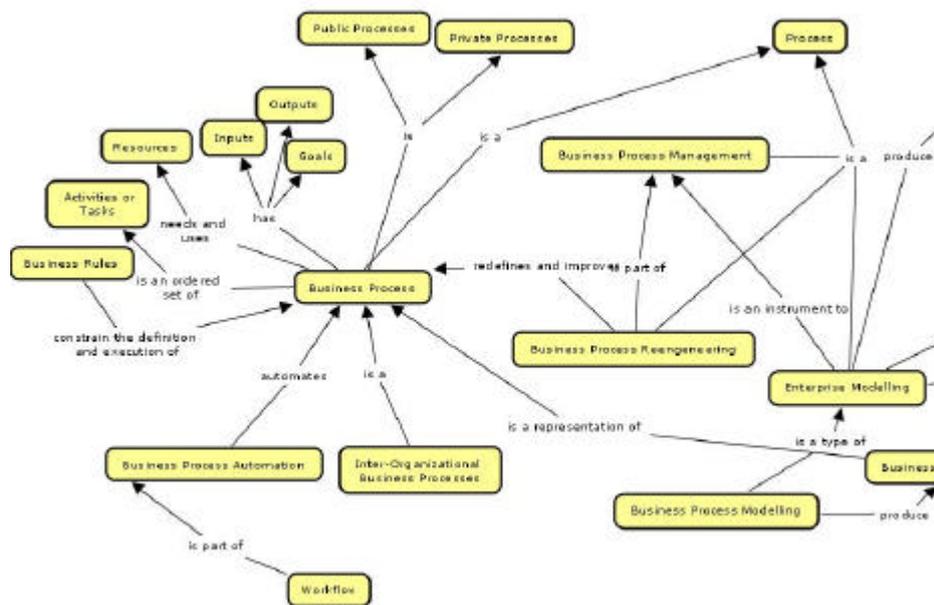
The definition of IOBP, from a business point of view, implies a close articulation with the software systems components available to support business process automation. In this field of research there are many similar terms used in different contexts with different meanings, many different approaches whose intervention objects must be clearly identified as well as many descriptive and execution languages whose scope and goals must be well understood. The clarification of the business process modelling field is beneficial both for the business architects and for information systems architects. An approach based on the conceptualization domain, more specifically on the conceptual maps approach, is an effective way to achieve such a clarification. This work has resulted in a conceptual map of the business process modelling field that enabled a critical analysis and the clarification of the relationships between business original concepts and software systems ones.

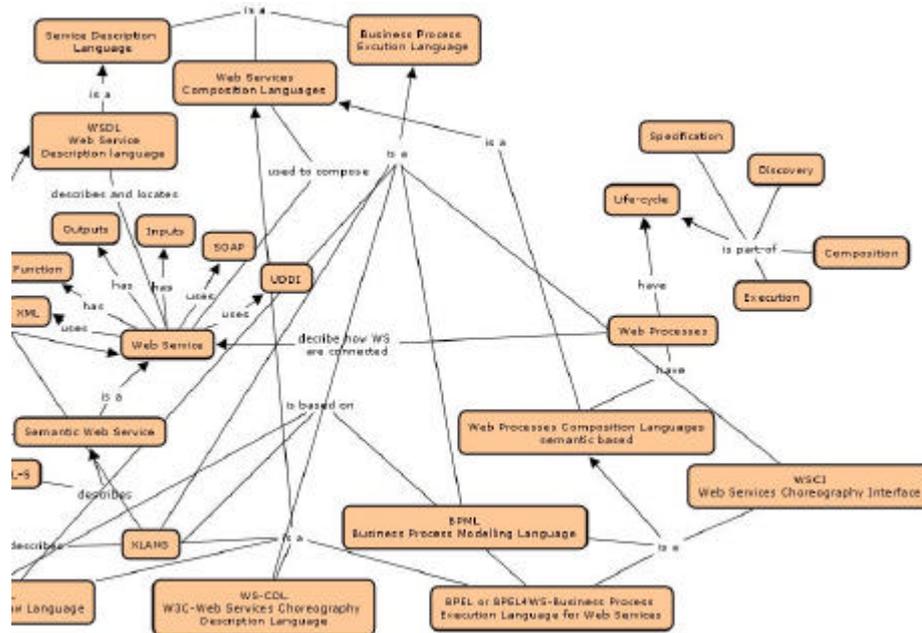
One of the works that we based on to build this concept map was on the Athena's Project [1]. The results of these works "focus on providing the means (languages, methodologies and tools) to engineer the enterprise and to show this specification as an enterprise model. These means are specifically designed for collaborative enterprises, providing different views over the model, allowing the exchange of models

between collaborating enterprises, and providing the necessary flexibility to adapt to the changing environment forced by external entities. “

The presented conceptual map tries to highlight the interdependencies among business processes and, information’s systems components and the adopted technologies.

This conceptual map is very condensed because of the innumerable concepts that are related the BPM covers. We will present it in several pictures for a better vision and understanding.





As we can see from the cmap approach Business Process models can have different goals. The classic vision of Business Process Modelling divides BPM in four different views, as represented in the cmap: Functional, Behavioural, Organizational and Information [2]. This traditional approaches lack the adaptability and agility of current web based business environments. There is a lack from high level modelling methods to lower levels implementation methods.

[8] Business Process Management refers to the monitoring, measurement, controlling and optimizing business activities using automation technologies. The Business Process Automation is a subset of Business Process Management concerned with the modelling and automating of individual processes. Business Processes Modelling includes the description of the structure and behaviour of an organizational activity such as process activities flow, the role of its actors, the rules actors use and the information's needs that these actor have.

Business Process Reengineering concerns with the redefinition of a process for better compliance, faster speed of execution using automation technologies.

In fact a business process involves multiple actors (people, business units,...), concurrent activities, explicit synchronization points (e.g. some task cannot start until several other concurrent tasks are complete) and end-to-end flow of activities. Business processes consist of partially ordered activities that correspond to the operations of their defined business in order to achieve their common goal. The information structure for a business process can be defined as a network of activities performed by resources so as to transform inputs into outputs [7]. An activity is an element that performs a specific function within a process. Activities can be as simple as sending or

receiving a message or as complex as coordinating the execution of other processes and activities [9].

[11] Technologies supporting collaborative communities must operate efficiently in an open environment with practically no geographical, cultural, and technical limits. This type of environment is characterised by the fact that participants are autonomous, i.e. they can come and go, and act independently and self-contained. For a specific purpose they may be willing to participate in loosely coupled communities, taking some role and responsibility and/ or providing some services. In such communities, they may negotiate and fix some agreements, perform some tasks, provide and/or access some information, and access or offer some resources, while others are restricted to their own use. Consequently technologies used in such environments must support loose coupling, autonomy, and flexibility on the one hand, and agreement making, trust and security on the other hand.

Currently research in BPM did acquire a new vision with web services. Web Services facilitate machine-to-machine interactions, they are self-describing, modular applications that can be published, located, and invoked across the Web.

A landscape of languages and techniques for web service composition has emerged and his continuously being enriched with new proposals. We will try to highlight the differences, capabilities and limitations between the different Business Process Modelling Languages [1]:

Language	Description
BPEL, BPELWS or BPEL4WS	Business Process Execution Language (BPEL) defines a notation for specifying business process behavior based on web services (is entirely defined in XML). Combines the both features of WSFL and XLANG.A business process is composed of several steps called activities.
BPML	Is a meta-language for the modeling of business processes BPML aims to provide a comprehensive means of specifying the processes of an enterprise, allowing that complete business processes to be embedded as activities within other flow models .
BPMN	BPMN stands for Business Process Management Notation and was developed by the Business Process Management Initiative (BPMI) to provide a notation that is understandable by all users, from the business analysts that create the initial drafts of the process to the technical developers responsible for the technological implementation of these processes. BPMN fulfils the gap between business process design and business process implementation.
WSCl	A mature XML language for web services choreography, or the statefull process-oriented interactions of web services among multiple participants.

WSCL	WSCL allows the business level conversations or public processes supported by a Web service to be defined. WSCL specifies the XML documents being exchanged, and the allowed sequencing of these document exchanges. WSCL conversation definitions are themselves XML documents and can therefore be interpreted by Web Services infrastructures and development tools.
XLANG	Provides language constructs to describe behavioral aspects of web services and combining those services to build multi-party business processes. At the intra-service level, XLANG extends WSDL language by adding a behavior element that defines the list of actions that belong to the service and in what order they should be performed. XLANG is a notation for the automation of business processes based on Web Services for the specification of message exchange behavior among participating Web Services.
WSFL	Allow complete business processes to be embedded as activities within other flow models. The flow model specifies the execution sequence between component services.
OWL-S	Is an ontology language for describing semantic web services

[2] Processes are relationships between inputs and outputs, where inputs are transformed into outputs using a series of activities, which add value to the inputs.

Business process models are mainly used to learn about the process, to make decisions on the process or to develop business process software. Some business process models are better suited depending on the specific purpose.

The main process modelling techniques used before were Flowcharts, Data Flow Diagrams (DFDs), Gantt charts, IDEF techniques, Coloured Petri-Nets (CPN), GRAI-GIM techniques, workflow techniques and UML among others.

We are particularly interested in the definition of Inter-Organizational Business Processes in the context of a Virtual Enterprise based to pursue of a business opportunity. However collaborative business processes need new methods that enable flexible business processes (section 2 gives a brief description of the existing methods and languages that enable collaborative business process modelling).

Modelling Collaborative Enterprises requires specific constructs and methodologies, and requires a certain level of wide-consensus for exchanging and merging behaviors of several entities into an orchestration operation. Flexibility and ability for a quick adaptation constitute the key for establishing collaboration among enterprises.

To fulfill this gap, some new approaches for Business Process Modelling were developed; the most promising are BPEL4WS, WS-CDL, BPML, WSCI, WSFL, XLANG and WSDL. All of these languages use Web Services based. Web Services is an emerging technology for building complex distributed systems focusing on interoperability that allows enterprises to describe the internal structure of their processes and how they can be invoked and composed; and also allows supported interactions between business partnerships based on the exchange of messages

However, each enterprise in the Virtual Enterprise probably has their processes described in different Enterprise Modelling Languages, which increases the degree of complexity for the exchanging of knowledge between these enterprises.

If we look carefully to the concept map we can see that Business Processes and Web Services both have common concepts (Inputs and Outputs).

A number of standards have been proposed over the past years for the process composition (WSFL, XLANG, BPML, WSCL and WSCI), however, these languages lack semantic expressivity, which has guided to the actual on going initiatives of standardization: the Business Process Execution Language for Web Services (BPEL4WS) and the WebServices Choreography Description Language (WS-CDL).

Web Process Composition is the task of combining and linking existing Web Services and other components to create new processes.

BPEL4WS defines a notation for specifying business process behavior based on Web services. Business processes can be described in two ways. Executable business processes model actual behavior of a participant in a business interaction. Business protocols, in contrast, use process descriptions that specify the mutually visible message exchange behavior of each of the parties involved in the protocol, without revealing their internal behavior.

[9] Ontologies are expected to play a central role to empower Web Services with semantics. The combination of these powerful concepts (i.e. ontologies and web services) has resulted in the emergence of a new generation of web services called semantic web services. One important challenge is service composition that refers to process of combining different web services augmenting their value.

3.2 Discussion

There are a lot of concepts with different meaning around Businesses Process Modelling and the conceptual map is the best way for us to clearly figure out how these concepts fit together and take some conclusions on this matter.

The existing methodologies to design business processes are naive in modelling Web application aspects (like information, transactions, and navigation patterns).

Technologies supporting collaborative communities must operate efficiently in an open environment with practically no geographical, cultural, and technical limits. This type of environment is characterised by the fact that participants are autonomous, i.e. they can come and go, and act independently and self-contained. For a specific purpose they may be willing to participate in loosely coupled communities, taking some role and responsibility and/ or providing some services. In such communities, they may negotiate and fix some agreements, perform some tasks, provide and/ or access some information, and access or offer some resources, while others are restricted to their own use. Consequently technologies used in such environments must support loose coupling, autonomy, and flexibility on the one hand, and agreement making,

trust and security on the other hand. The following outlines some technologies that are considered to specifically support such environments.

[13] Each network enterprise has its own private methods of process modelling methods (Petri-Net, UML, DFDs, and so on) and tools. Due to the lack of common interfaces and mapping-methods, neither can tools interact with each other nor can the methods be transformed into one another. To extract information relevant to the network from these "private processes", a collaboration specific view is generated, providing all or at least some information (white-box) or in a black-box manner with no indications about their realization (only the interfaces of the private process are described). Private processes must be protected from external insights but at the same time integrated into the whole collaborative process for the extended approach of Collaborative Business Process Management.

4 Conclusions and further work

This paper provides a survey of the current research in BPM through a conceptual map. We have tried to highlight the deep relationships between the most important concepts in the field of Business Process Modelling that, as we may conclude, requires new forms of flexibility in today's business changing environment. In our approach we consider a Breeding Environment where a set of enterprises exist and have the intention to cooperate with each other in order to maintain a set of social relationships, mainly trust relationships, that can be mobilized to join resources and collaborate to compete for a business opportunity. A Breeding Environment represents an association of enterprises that have the intention to cooperate with each other in order to establish a long term cooperation agreements and an interoperable infrastructure. When a Business Opportunity is detected a subset of this Breeding Environment can be selected to accomplish these Business Opportunity. Our goal is to apply a Multi-Agent System (MAS) in the discovery and inter-organizational articulation of individual public Business Processes. Web services coordination between organizations must be preceded by the definition of the IOBP. When we deal with the setup of temporary collaborations of enterprises to take advantage of a given business opportunity, one fundamental step is to articulate individual BP in order to achieve a set of inter-organizational processes that satisfy the business goals. Research work on MAS applications did not favor this problem, and we believe that this is an important research direction. Semantic interoperability is crucial to assure a meaningful interaction, communication and cooperation among the heterogeneous agents and services.

Factors like: distributed system architecture, reactivity to changes, interoperation among heterogeneous systems, resource management and intelligent decision making are some of the advantages of using a Multi-Agent System.

The enactment of IOBP is fundamental for enterprises to create new partnerships efficiently and in a quick way. To accomplish this a few requirements are needed:

Define a Business Process in a detailed and comprehensive way is a complex task because of the dynamic environment they are involved in, such as complex business rules and policies, abnormally action from the involved partners, among others.

The definition of IOBP in a Virtual Enterprise is still a challenging issue for the research community. In spite of the several approaches being made in this area, there seems to be an agreement that the agent-based systems are the most promising technology that address the IOBP life cycle, since they can effectively support agility by adapting themselves to the continuous environment changes. Furthermore, agent technology provides enterprises the ability to learn both from their individual behavior and from the cooperative relations with others. One of our future directions is to improve the definition of the IOBP using a learning approach within social networks modelling to optimize the IOBP selection by adding social relations parameters of negotiation.

The development of such a decision support system requires a set of concepts that provides a systematic way to define IOBP. IOBP possess characteristics that require different design approaches than the one founds in traditional systems. One of these characteristics is that IOBP are emergent and cannot be defined a priori. IOBP include intensive interactions where experts merge tacit and explicit knowledge to create and exchange ideas in order to identify the next process step.

This paper presented a conceptual analysis of the main fields dealing with BPM with the goal of clarifying conceptually the uses of BPM in the management and computer science fields, clarifying the BPM concepts and their relationships. Also an important goal (and the first aim of our work), is to set up a solid conceptual basis for interdisciplinary research in this area.

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