23 DISSECTING INTER-ORGANIZATIONAL BUSINESS PROCESS MODELING: A LINGUISTIC AND CONCEPTUAL APPROACH

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The main objective of this paper is to contribute to the understanding of the of Business Process Modelling field focusing on the definition of the Inter-Organizational Business Processes from both a high-level modelling perspective and a technological one. We used a conceptual maps' approach in order to clarify all the fundamental concepts that surround these two fields. We will present the two conceptual maps we have achieved through the help of a web-based tool for corpus linguistics and knowledge engineering named Corpógrafo and using the IHMC Cmaps Tools for the design of the Conceptual maps.

1. INTRODUCTION

The fast and increasing development of networked business environments brings new ways of interaction among the enterprises, which eliminated the time and space gap between business partners. Enterprise Networks is a new organizational structure that accomplishes the requirements of dynamism and agility that electronic commerce entails. The automation of Enterprise Networks activities in dynamic environments, as it is the case, is still, in most business-to-business scenarios, an undergoing research topic. Business pure models and business process technologies research field for the design, definition and enactment of Inter-Organizational Business Processes (IOBP), focuses mainly on one of these features, failing when connecting the two. On our work we will try to fulfil this gap and attempt to combine both views, which is an actual and challenging research field.

In business networks, management information systems should be based on three fundamental ideas: networked collaboration support, networked decision support and networked knowledge management. The management of a network of enterprises can in fact be viewed as the management of relationships and interactions between the different actors, directly and indirectly involved in the activities. Relationships involve operations, processes, resources, knowledge, social interaction, trust, power, etc [16].

Business Process Modelling (BPM) is a well established research and practice

field (thought immersed in different research topics such as Enterprise Modelling or Information Systems Architectures, to name just two on 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. BPM is still an ongoing research topic. In fact, BPM is a research challenging issue, especially focusing on the expression of interdependencies among business processes, information systems components and the emerging web technologies. Recently, BPM has gained a new breath pushed by the technological development in the area of internet/web technologies: web processes, service oriented architectures (SOA), semantic web, among others. Although dealing with the same object of study - the inter-organizational business processes - the terminology used by both communities can sometimes be confusing. This happens due to 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.

This paper describes a research work encompassing a linguistic and conceptual analysis of the main fields dealing with BPM with the goal of conceptually clarifying the uses of BPM in the management (pure business perspective) and computer science fields (pure technological perspective). The main objective of this work is to contribute to the understanding of the BPM field focusing on a business architecture perspective and from a service oriented architecture one. Also an important goal (and the first aim of our work), is the setting up of a solid conceptual basis for interdisciplinary research in this area.

The paper is structured as follows: Section 2 presents the method for the linguistic and conceptual analysis of Business Process Modelling. In section 3 the two perspectives on Business Process Modelling presented are contrasted using a conceptual maps' approach. Section 4 synthesises some related work in the BPM field and section 5 presents some conclusions and points for further research.

2. A METHOD FOR A LINGUISTIC AND CONCEPTUAL ANALYSIS OF BUSINESS PROCESS MODELLING

Two corpora were defined as *a priori* analytical categories for business process modelling related papers: *business architectures* [5, 17] and *service oriented IT architectures*. The fundamental reason for choosing these two specific corpora was to make a deep analysis of these complementary domains of BPM research. Complementary because we cannot separate these two perspectives as they are intertwined. In fact, the second perspective is the technological implementation of the first one. So in order to automate an IOBP it is essential to understand the management perspective of BPM very clearly.

The method for the linguistic and conceptual analysis included the following steps:
 1. selection of the papers to be included in the two corpora,
 2. identification and selection of terms using a linguistic analysis tool,
 3. elaboration of two conceptual maps using the terms selected in 2,
 4. analysis of the conceptual maps regarding conceptual similarity,
 5. disambiguation of similar terms in the two corpora.

In the first step, relevant papers of the two fields were selected, according to our purposes. Research in the BPM field exists for more than a decade, so several state-of-the-art and survey papers were selected (aprox. 65 papers). The same with the Business Architecture (BA) in SOA (aprox. 32 papers) [1, 9, 19]. Several papers where the link between BPM and SOA aspects was dealt with, were also selected [20, 8, 3].

The second step was undertaken with the help of *Corpógrafo*. *Corpógrafo* is an integrated web-based tool for corpus linguistics analysis and knowledge engineering. It is a computational environment on the web that allows users to build and research personal corpora without the need for specialized technical skills or additional software, apart from a web browser [13]. This tool helped to extract a set of candidate terms from each corpus, which formed the raw material for our analysis. From this set of candidate terms (about 65 for BAs and 30 for SOAs) a selection was made of those that stood for concepts more relevant to BPM.

The following step, and the most important one for the construction of the conceptual map, was to identify the relations between the selected concepts. This was also done using *Corpógrafo* but it was mostly based on the study of the selected papers covering these two research topics and on our knowledge of the domain. The result of steps 1 and 2 paved the way to build two conceptual maps for each of the areas which are described in the following section.

3. CONTRASTING THE BP MODELLING VIEWS USING CONCEPTUAL MAPS

To identify appropriate concepts shared in the business processes community there is the need to analyze and describe the business process (BP) itself. A *Business Process* is a set of ordered activities of an enterprise or of a network of enterprises that are executed according to some rules in order to achieve a goal. They are performed by one or more actors in a process. An actor can be an organization, a person, a software agent representing a person or an organization.

Different business process models are employed in the design and implementation phases of the Business Process Management life-cycle, where the business analyst perspective serves as input for the technical analysis for BP implementation. The translation between these two perspectives is prone to semantic ambiguities. First, because the two perspectives employ different business process modelling languages and secondly because there is an "identified gap" on the type of resources used by the activities in the two perspectives, namely the human resources which cannot be contemplated in the technological definition of the IOBP but definitely exists in the high-level IOBP definition we are trying to achieve. We used a conceptual maps approach in order to clarify all the fundamental concepts that surround these two perspectives: management and technological.

Conceptual maps are simple and practical representation tools that allow the representation of knowledge in the form of a graph and are an effective way of representing complex concepts and messages in a clear and understandable way [4]. The two conceptual maps, one for each corpus, were built using the IHMC Cmap Tools software [6].

3.1 A conceptual map for BPm from the BA point of view

The main objective of BPM is to provide a better understanding on how to express the business processes, their strategies and their behaviour. Business models provide ways of expressing business processes or strategies in terms of business activities and collaborative behaviour so we can better understand the business process and the participants in the process. Models are helpful for documenting, for understanding and communicating complexity. A *Business Process Model* is a representation that tries to capture the business processes which are essential to the organization function's understanding and performance, reflecting the business environment reality. BPM is not a recent research field; there are a lot of business processes modelling techniques that range from traditional data modelling (DFDs, Entity-Relationships Diagrams, IFEF-0, etc) to behaviour modelling techniques (State Transition Diagrams, Petri Nets, Role Interaction Nets, etc) [18]. A *Business Process* defines the behaviour of the process itself; it is a function that has *inputs*, *preconditions* that must be satisfied, *outputs* that result from the execution of the process and *results*. *Activities* in a business process can be business processes themselves, sub-processes or tasks - the basic part of a business process that cannot be divided. To model a business process we need to describe the BP itself in a detailed, reliable and unambiguous way which means we have to know *a priori* the activities involved in a BP. The BPM research community agreed that the three main views involved in BPM are *behavioural*, *organizational* and *informational* views. The behavioural perspective basically describes the order in which the different activities are executed. The organizational view describes the organization structure and, in particular, the resources and in which way these are involved in the BP. The informational point of view describes the information that is involved in a BP, how it is represented, and how it is propagated among the different activities. The conceptual modelling languages such as IDEF, Flow Charts, DFDs, Eriksson-Penker Business Modelling extension and UML are all graphical modelling languages but they only focuses on one of the views, e.g., the business view.

3.2 A conceptual map for BPm from the SOA perspective

The need to build complex business process, e.g. IOBP, in these highly competitive and dynamic business environments requires new methods and tools. Nevertheless, Web Services is an emerging technology that seems to meet this demand. Web Services technology is used for building complex distributed systems focusing on interoperability, which allows enterprises to describe the internal structure of their processes and explain how they can be invoked and composed. It also allows supported interactions between business partnerships based on the exchange of messages. This way, organizations can extend the business processes beyond the enterprise boundaries via this technology, thereby improving collaboration across partners and facilitating dynamic reconfiguration of business processes. A Web Service is like a unit of work which can complete a specific task [15]. Many businesses are adopting Web service technology to expose their business applications, allowing them to have business collaboration both within their organization and with business partners outside the organization. However, each enterprise has their processes described in different modelling languages, which increases the degree of complexity to exchange and share the knowledge between the enterprises involved in an IOBP. To fulfil this gap, some new approaches for

Business Process Modelling were developed; the most promising are BPEL4WS, WS-CDL, BPML, WSCI, WSFL, XLANG and WSDL which are XML (eXtensible Markup Language) based languages. WS-CDL and WSCI are languages appropriate to model abstract processes, e.g., they include every type of action executed between organizations and are accessible to the partners' organization [12]. The others are suitable for private processes, e.g., a process that describes the internal executable activities that support the activities of public processes [2]. A private process is private to the organization which means that the knowledge it possesses is restricted to the enterprise it belongs to. On the contrary, a public process has information that must and should be shared with other processes in order to obtain a composition of business processes that will form the IOBP. These concepts are also strongly connected with other two concepts: composition (or orchestration) and choreography of web services and we have adopted the following ones [9, 18]: *Composition* refers to the definition of the internal implementation of the executable business processes. *Web Services Composition* defines executable business processes that are built from a set of web services. *Orchestration* is usually private to the business party, since it contains reserved information (business strategies, business rules and business policies) on the specific way a given process is carried out. *Choreography* defines externally observable behaviour of a business process. Web Services *Choreography* refers to the correct content and order of messages that two parties exchange in a business process. *Choreography* is usually public, since it defines the common rules that make for a valid composition of the distributed business processes in the business domain; it describes collaboration among the needed enterprise services in order to achieve a common goal.

3.3 Connections and disambiguating of BPm concepts in the BA and SOA areas

We will now identify some near concepts through the analysis of the presented conceptual maps, e.g., to disambiguate different concepts with the same name and near concepts with different names referring to the two conceptual maps.

Form the pure business point of view, the central key element of this conceptual map is the term Business Process, through the use of diverse conceptual and formal languages. Business Processes have pre-conditions, inputs, outputs and goals; they execute a set of activities that consume resources. Whilst in the SOA approach, although we mention the BP concept, the BP is represented by a Web Service. The web service has inputs, outputs, a transforming function and its description is made through a specific language (WSDL-Web Service Definition Language).
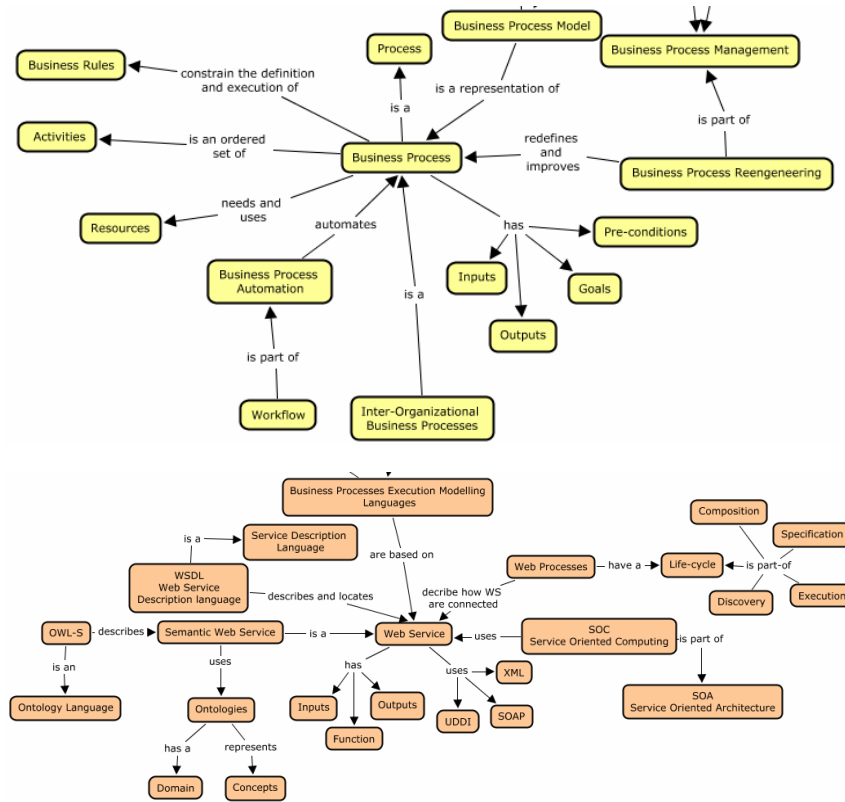
Figure 1

The concept of IOBP from the high level management perspective has the correspondent SOA approach, as choreography of web services. Much like what we can see through the concepts represented in the previous and following scheme.
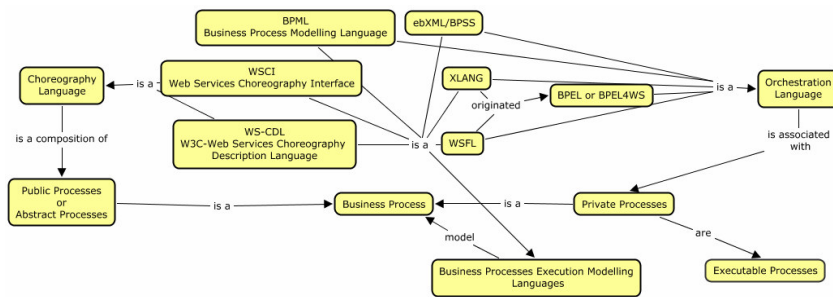

Figure 2

4. RELATED WORK

There is a lot of work done on the definition of BP modelling languages, but it

clearly misses some research clearly addressing the gap between the referred two complementary fields. [8] This paper aims at the realization gap between business and technical processes, discussing the differences between the processes modelled from the pure business perspective and those modelled with consideration of technical aspects. Designing a BP from the business point of view needs the message exchange between, activities and roles that are part of a process. However, when designing executable processes, attention must be paid to the business requirements and also to the technical context where the process should be executed. It also presents the design requirements that must be followed in order to create a lossless realization of a BP; their approach, based on a process description framework, defines the possible transformation needed when constructing a technical process from a business process.

According to [14] "There clearly exists a gap between the high-level process models used in the early stages of the process management life cycle and the detailed execution models of the implementation and enactment stages. This gap manifests itself in the following points: lack of an appropriate language that covers both high-level process design and low-level process execution; lack of appropriate conversion between languages of different stages of the process management life cycle; and lack of guidance for the conversion of high-level process models into low-level executable models".

The goal of BPMN [7] is to provide a business process modelling notation that is readily usable by business analysts, technical developers and business people that manage and monitor these processes. As such BPMN positions itself as a bridge between modelling and execution and between people that run the business and implementers of systems that support the business.

5. CONCLUSIONS AND FURTHER WORK

Modelling the IOBP integrating both the approaches - business and technological - is still far from being achieved. Modelling IOBP requires specific constructs and methodologies, and requires a high-level model and the corresponding executable one for exchanging and merging behaviours, resources and activities. The definition of IOBP from the management perspective only deals with the describing in what order the activities should be performed by the involved organizations in order to achieve a business goal. Whilst in the technical perspective the technological limitations must also be considered. The activities in the technical process can differ from the activities in the management business process (e.g., human resource activities cannot be modelled in the technical approach), regarding the goals, the message exchanges, the business requirements, among others. The analysis of the obtained conceptual maps and the revision of literature undertaken points out that Web Services seem to be a very appropriate communication mechanism to perform distributed business processes among several organizations, mainly because they are invoked and delivered through the Internet and also because they provide a standard interface. In our work we will try to bridge the gap between high level BP models and the execution of the IOBP achieved through the composition of the IOBP. The main objective of our work is to contribute to the understanding of Business Process Modelling field focusing on the definition of the IOBP, and for that we will need to generate a high level model for the IOBP and we will implement a prototype based on a Multi-Agent System (MAS) technology. Defining a BP 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 focuses of research are the composition of IOBP, at the management level, through semantic matching of business process descriptions, including goals, operational requirements and business rules; and the application of learning approaches in MAS to manage the composition of IOBP, dealing with the evolution of the languages and vocabularies that underpin business rules, business models, and the regulatory framework.

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