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Building ontology based knowledge maps to assist business process re-engineering

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ABSTRACT

Business Process Re-engineering (BPR) is being used to improve the efficiency of the organizational processes, however, a number of obstacles have prevented its full potential from being realised. One of these obstacles is caused by an emphasis on the business process itself at the exclusion of considering other important knowledge of the organization. Another is due to the lack of tools for identifying the cause of the inefficiencies and inconsistencies in BPR. In this paper we propose a methodology for BPR that overcomes these two obstacles through the use of a formal organizational ontology and knowledge structure and source maps. These knowledge maps are represented formally to facilitate an inferencing mechanism which helps to automatically identify the causes of the inefficiencies and inconsistencies. We demonstrate the applicability of this methodology through the use of a case study of a university domain.

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1. Introduction

Business process re-engineering (BPR) has been defined as the fundamental rethinking and radical design of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service, and speed [18]. Although there were high expectations for the improvements in performance that BPR would bring about for organizations, in many cases these benefits were not realised and high failure rates (e.g. 70%) have been reported [2, 5, 27].

The reasons for these high failure rates have been debated and a number of factors have been posited as to why these expected benefits have not been realised. One factor is the focus on the steps in the business process (e.g. business process diagrams) at the exclusion of the environment within which the process is carried out [42]. In considering the environment organizations will be faced with the challenge of making certain types of knowledge visible to relevant stakeholders. Another factor is that although there are a number of tools for modelling the business processes, many of these tools only support diagrammatic and mathematical modelling [39]. While these models are useful for understanding the business processes, they do not support the automated analysis for identifying the cause of inefficiencies in the business process, which is considered to be one of the most time consuming stages of BPR [1, 39].

This research addresses the issues of the lack of understanding of the environment within which the business process exists and of automating the identification of the inefficiencies and inconsistencies in the business process. The lack of understanding of the environment suggests the need for the integration of knowledge management models and techniques [3]. One such knowledge management technique that could be relevant is knowledge mapping, as knowledge maps can be used for several purposes, including finding sources of knowledge or opportunities for knowledge creation, identifying expertise and increasing knowledge-sharing, and helping to determine the knowledge competencies that exist within an organization [9, 37] and how they interact. The lack of automated methods can be addressed by representing the business processes and the environment using a formal notation. Alleviating these problems will improve the BPR efforts and ultimately help organizations realise the benefits that have been anticipated.

In this paper we use a design science approach [19] to develop a methodology that incorporates a number of existing techniques, namely ontologies and knowledge maps, to ensure that both the process and its environment are modelled when re-engineering is being undertaken by an organization. The methodology also proposes an automated mechanism for analysing these domain models by using a formally represented ontology which facilitates automated inferencing. The applicability of the methodology will be demonstrated by applying it to a university domain.

The following section describes the BPR, ontology and knowledge literature. The methodology is then described and evaluated using a case study. The applicability of the methodology for this domain is then discussed and finally the conclusion and suggestions for future directions for this research are presented.

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2. Background Research

2.1. Business process re-engineering

There are a number of definitions of Business Process Re-engineering (BPR) that differ somewhat in their focus [27]. It has been defined as a process that involves analysing and designing workflows and processes within and between organizations [7]. It is also defined as fundamental rethinking and radical design of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service, and speed [18]. The critical components of BPR are fundamental rethinking and redesign of operating processes and organizational structure, with an objective to achieve dramatic improvements in organizational performance [22].

The steps that have been associated with BPR include, defining a vision and mission to prepare for BPR, mapping and analysing the current processes (i.e. the *AS-IS* process), identifying improvement opportunity and designing new processes (i.e. the *TO-BE* processes) and implementing reengineering processes [24, 25]. Mapping and analysing *AS-IS* processes and designing *TO-BE* processes requires a careful analysis of the process under consideration. Several techniques have been used for modelling these business processes to improve their understanding [1, 40, 41].

A number of techniques exist for modelling the business processes [1, 39, 40]. These techniques include Business Process Modelling language (BPML), Petri-nets, Unified Modelling Language (UML), flowcharts. Vergidis et al. [39] classify these techniques according to their analysis and optimization capabilities (i.e. diagrammatical, mathematical and business process languages). They emphasise that although there is an abundance of techniques for modelling there is a lack of those that are suitable for analysis and optimization.

The risks associated with BPR are high and failure rates as high as 70% have been reported [15, 20]. This lack of success has been attributed to the lack of tools and methods for managing change while others have attributed it to a lack of connection between BPR efforts and the corporate goals [4]. According to Attaran [4] many organizations who reengineer focus on the process design and ignore the importance of the people and how their tasks would be affected by these changes. Yu & Mylopoulos [42] emphasise that business processes exist in a social organizational setting, where organizations are made up of actors who perform certain roles to achieve their goals through a network of relationships. Hence it is important to know not only the '*what*' in the organization (i.e. what entities exist, what activities occur and what relationships hold) but also the '*why*'. This can be achieved if the organizational knowledge is taken into consideration.

2.2. Organizational knowledge

A knowledge perspective represents the different types of knowledge within an organization, for example, *Know-Why*, *Know-What*, *Know-How* and *Know-Who*. Knowing is defined as how knowledge works in a business system and is important in understanding how knowledge is used in the processes [3, 8, 30, 36]. The emphasis of this knowledge perspective is not just on processes but on system wide knowledge. *Know-What* is the knowledge about the facts in the domain and also the knowledge of what to do. This is embedded in the process instances (i.e. practices) of an organization. *Know-How* is the knowledge that is inherent in the chains of causality between processes. *Know-Why* is related to how goals interact with each other and thus focuses on knowing why certain things are done rather than how they are done. *Know-Who* is the knowledge about *who knows what* and is embedded in the interactions among actors and roles and social networks. *Know-Where* is related to the location of assets in the organization. Having access to all these types of knowledge will help strategic decision makers to examine not only the business process but also the environment within which it exists. Hence, it is important that this knowledge can be modelled so it can be easily accessed during BPR.

A knowledge map is a knowledge representation technique that reveals the underlying relationships of the knowledge sources using a map metaphor for visualization [28]. Eppler [8] categorized different types of knowledge maps; knowledge source maps, knowledge asset maps, knowledge structure maps, knowledge application maps and knowledge development maps. The knowledge maps provide views to different types of knowledge. For example, knowledge structure maps define the different roles which come together to perform a set of tasks so can be used to identify the *know-what* and *know-how*. Eppler [8] summarized the different types of knowledge maps and aspects of organizational knowledge they represent.

2.3. Organizational modelling

Several organizational modelling techniques exist, for example, AALADIN, Agent/Group/Role (AGR), MOISE+, Agile Integration Modeling Language (AIML), Enterprise Ontology, each of which focuses on a specific aspect of an organization. AALADIN and AGR focus on modelling the structural aspect of the organization (e.g. groups, roles and agents) [10, 11]. MOISE + focuses on the functional aspect of the organization (e.g. goals, plans and mission) [17]. AIML focuses on goals, roles, agents, tasks and interactions [21, 43]. An enterprise ontology considers an enterprise model to be a computational representation of processes, information, resources, people, behaviour, goals and constraints [12] and therefore can be considered to be an encapsulation of the other modelling techniques.

Ontologies provide a framework for facilitating effective and efficient knowledge-sharing by formally modelling the domain of discourse [16]. An organizational ontology provides a set of terms and constraints that describe the structure and behaviour of the organization [13, 43]. They have been used for modelling the enterprises activities, processes, information, resources, behaviour, goals and constraints [12].

Noy and McGuinness [26] highlight several benefits of developing an ontology to make domain assumptions explicit, these include: (1) facilitating the sharing of a common understanding of the structure of information among stakeholders in a domain (2) facilitating more effective communication and idea-sharing (3) assisting new entrants in a field to quickly assimilate important domain concepts and knowledge and (4) generally supporting the analysis of domain knowledge.

Some of the benefits of using ontologies for BPR have been recognised [6, 14]. Galatescu and Greceanu [14] speak to the importance of ontologies for a common vocabulary and understanding and the use of the formal notation for inferencing. Cottam et al. [6] describe how knowledge acquisition techniques and ontologies support the acquisition and organization of process knowledge during BPR.

There are a number of existing tools that support the development of formal ontologies, one such tool is Protégé-OWL, a suite of tools to construct domain models and knowledge-based applications with ontologies (http://protege.stanford.edu/). OWL is the most recent development in standard ontology languages, endorsed by the World Wide Web Consortium (W3C) to promote the Semantic Web vision. The OWL ontology may include descriptions of classes, properties and their instances. Given such an ontology, the OWL formal semantics specifies how to derive its logical consequences (i.e. facts not literally present in the ontology, but entailed by the semantics). Thus, the OWL language facilitates:

i. formalizing a domain by defining classes and properties of the classes
ii. defining individuals and asserting properties about them
iii. reasoning about the classes and individuals to the degree permitted by the formal semantics of the OWL language.

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