A Semantic Framework for Knowledge Management in Virtual Innovation Factories

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ABSTRACT

Knowledge management is a crucial aspect for enterprises that want to effectively cope with business innovation. However, the full control of the knowledge asset is often missing due to the lack of precise organizational models, policies, and proper technologies, especially in Virtual Enterprises (VEs), which are characterized by heterogeneous partners with different policies, skills and know-how. For such reasons, the need for technologies that enable knowledge sharing, efficient access to knowledge resources, and interoperability is felt as primary. This work proposes a semantics-based infrastructure aimed at supporting effective knowledge management for business innovation in VEs. Knowledge resources are formally represented and stored in a semantic layer, which is exploited by a set of semantic services for enabling efficient retrieval and reasoning capabilities to derive additional knowledge.

Keywords: Business Innovation, Computational Ontology, Knowledge Sharing, Semantic Knowledge Management, Virtual Enterprise

INTRODUCTION

Among the most recent innovation paradigms, open innovation is gaining ground. Open innovation is defined as “a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market” (Chesbrough, 2003). This definition recalls the notion of Virtual Enterprise, that is, a networked organization where different autonomous entities collaborate towards a common goal. In particular, we introduce the notion of Virtual Innovation Factory (VIF) as an innovation-oriented Virtual Enterprise whose goal is to support the production of innovation. The latter takes place in the Business Innovation Space (BIS), where active entities are, beyond the R&D innovation teams, final users, partners

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or even competing companies, and other actors operating outside the enterprise boundaries. Operational processes pertaining to the BIS define the core innovation value chain: sourcing raw ideas, transforming them into products (goods and services), marketing and delivering new products. Finally, processes for the planning and monitoring of innovation projects conducted in the BIS characterize the managerial level of a VIF. All these kinds of activities require intense collaboration, communication and interaction, and ultimately a high level of knowledge sharing among the involved autonomous actors. Indeed, knowledge is the main factor that enables continuous innovation in a world of rapidly changing markets, products, services and technologies (see, e.g., Nonaka, Toyama, & Konno (2000) for a thorough discussion of the notion of knowledge and its role in enterprise management). Efficient access to knowledge resources is however hindered by interoperability issues coming from fragmentation and heterogeneity of the involved players, their data, information and knowledge resources.

In order to overcome interoperability issues and enable knowledge sharing, we propose an approach based on semantic technologies. In particular, as the main contribution of the paper, we propose the design principles and preliminary prototype definition of the Production and Innovation Knowledge Repository (PIKR), a semantics-based repository for knowledge resources related to the Business Innovation Space where the VIF operates. The PIKR also stores and manages knowledge about the ordinary production activities which are relevant to the VIF. However, in this paper we will mainly focus on the innovation related aspects.

The PIKR is a virtual repository since resources physically reside locally, at VIF’s partners, while the repository will host and manage an ontology-based image of such resources, as the result of their semantic description. The design principles of the PIKR descend from the analysis of user requirements and of the methodological framework elaborated within the European project BIVEE that lead to the recognition of core elements to be semantically described, namely Documents, Business Processes (BPs) and Key Performance Indicators (KPIs), and the relations among them. Furthermore, the paper describes a set of services, enabled by the semantic representation, providing smart access to stored resources, facilitating the sharing of contents, and supporting the information and knowledge interoperability with the ultimate goal of supporting innovation project management.

The paper is organized as follows: the next subsections discuss the BIVEE Innovation Framework, provide an analysis of requirements for the PIKR, and briefly survey related work. Then, in section “Semantic Framework” the core PIKR ontologies are discussed. Section “Semantic Services” describes a set of functionalities for searching, querying and reasoning over knowledge resources and their use for supporting innovation management. Section “Technical Realization” introduces the architectural organization of the first prototype of the PIKR.

**BIVEE Innovation Framework**

The BIVEE project elaborated the Business Innovation Reference Framework that works as the methodological framework to create and manage knowledge in the BIS. The framework is characterized by the following elements:

- **Loosely structured processes:** Achieving innovation is a different venture each time and it may largely vary depending on the nature of the sought innovation. Despite this very unstructured nature of innovation processes, some invariants, at a general level, do exist. BIVEE proposes the notion of wave (see below) to articulate an innovation venture.

- **Human-centric, document-driven approach:** The absence of rigidly defined processes requires providing guidance and support to innovation teams without constraining their creative attitude. BIVEE proposes a document-driven approach, where the goals to be achieved are repre-
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