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A semantic-based platform for R&D project funding management

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ABSTRACT

Innovation is one of the keys to success in the business world, particularly within the current economic climate. R&D projects constitute the building blocks of the innovation process, hence the importance of searching for funding for these projects. As ontologies and semantic technologies mature, they provide a consistent and reliable means to represent and aggregate knowledge from different sources. The present work explores the use of ontologies to model R&D grant funding calls and the application of semantic technologies to the development of an enhanced funding management system. Our experiments confirm the success of the proposed approach, and reveal that it may bring considerable benefits to R&D funding.

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1. Introduction

Innovation involves developing, assuming and successfully exploiting new possibilities in the financial and social fields in an attempt to bring new solutions to problems and to enable the fulfilment of the needs of both individuals and society. Innovation has been extremely valuable for decades, and is becoming even more important within the current global economic context. The discovery of new improved products or services can certainly lead to competitive advantages for companies, thus differentiating them from their competitors. In practice, innovation usually means improving the quality of products and reducing their price, in addition to boosting productivity. Closely related to the concept of innovation in corporations is research and development (R&D) project management, which is defined as a general set of processes and procedures with which to ensure that the company succeeds in all its objectives. R&D project management is an important task for government-funding agencies and research institutions, and usually involves several phases, namely, proposal writing, funding selection, proposal submission, project selection, approved project administration and project deliverable dissemination. If the critical decisions of each one of these phases in R&D project management are to be supported, then project related information needs to be shared among different parties with disparate knowledge backgrounds and at different organisational levels [1]. Project selection and funding is therefore an important task in both for-profit and not-for-profit organisations, and is applied to a wide and diverse

range of decisions: the dynamic selection and trimming of R&D investment, the dynamic selection of risky capital investments, etc. [2].

In line with this, many countries spend sizeable sums of public money on R&D funding to promote and increase their levels of science and technology with R&D projects. These funds are divided among different national and international R&D grant programmes and calls. These public funding programmes and calls have different features, and could potentially be oriented towards different areas, such as energy, information and communication technologies or agriculture. The focus in these programs could also be on a number of different beneficiaries such as small and medium enterprises, universities or non-profit organisations. These public funding calls may additionally be oriented towards forming a consortium between entities from different countries or regions. Furthermore, some calls have a deadline by which grant proposals must be submitted, while others do not have a specific deadline and proposals can be submitted throughout the year. All in all, when considering both the numerous tasks and phases involved in R&D project management and the heterogeneity and diversity of funding programmes, R&D project funding is a broad and complex domain. More particularly, deciding which funding programme and call is the most suitable for a given R&D project is an extremely challenging task.

Semantic technologies are, however, in an advanced stage of development [3] and provide a reliable basis for the challenges of the organisation, manipulation and visualisation of data and knowledge. Ontologies are the fundamental technology for the Semantic Web. An ontology can be defined as “a formal and explicit specification of a shared conceptualisation” [4]. They provide a formal, structured knowledge representation, with the advantage

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of being reusable and shareable. They also offer a common vocabulary for a domain and define the meanings of the terms and the relations among them with different levels of formality. The knowledge in ontologies is mainly formalised using five kinds of components, namely classes, relations, attributes, axioms and instances. Although their classes are usually organised into taxonomies, there are certain works in which taxonomies are considered to be full ontologies [4]. Among other applications, the use of ontologies may help overcome the limitations of traditional methods in natural language processing. They are also relevant in the scope of some related methods such as semantic search [5], service discovery [6], information retrieval [7] and expert finding [8]. It is also worth noting that ontologies have been applied in numerous domains, such as tourism [9], robotics [10] or biomedicine [11,12]. Ontologies are thus the key to success for Semantic Web representation.

In view of the above, the present study makes use of ontologies to obtain and represent information. We specifically present a semantic-based platform to assist in R&D project funding management. The proposed platform stores the semantic description of previously conducted R&D projects and currently available R&D funding calls. If a new project is proposed, then the system described here is capable of retrieving the previous R&D projects and calls registered on the platform that are most similar to it. The remainder of the paper is organised as follows. Section 2 presents a discussion of the related work. The components of which the platform is composed and its overall architecture are described in Section 3. Section 4 shows a use case scenario in the information and communication technologies (ICT) domain. The results of the experiment are discussed in detail in Section 5. Finally, our conclusions and future work are presented in Section 6.

2. Related work

Companies not prepared to meet the changing demands of their customers and potential customers are at risk of losing them to better prepared competitors [13]. R&D allows companies to be one step ahead of their competitors, and leads to attractive high-quality products and improved, efficient manufacturing processes. Providing a platform on which to manage R&D projects is an important step forward for those companies who are searching for solutions to customer needs [14]. Many experts in the field are consequently working on projects with the express purpose of facilitating knowledge management in R&D projects. Nowadays, R&D management is closely related to the integration of and collaboration among different stakeholders [15]. R&D can be described as a network of actors (e.g. competitors, suppliers, distributors, etc.) who seek collaborations within a wider system. Semantic Web technologies are increasingly used in this field with the aim of enhancing the knowledge management process [3]. In particular, these technologies have already been used to undertake the management of knowledge in R&D projects.

Knowledge management systems can benefit from ontologies that provide conceptual models in a formal manner, and ontologies are already being incorporated into real-world project solutions in this context. For instance, [16] describes an integrated knowledge management architecture for companies. Similarly, [17] proposes an ontology-based system with which to manage innovation projects. Here, the main goal is to boost companies' competitiveness by facilitating the acquisition of knowledge from new innovative products. This ontology-based platform is intended to support employees in the knowledge acquisition process. Other systems, such as that presented in [18], focus on providing approaches that will enable the management of R&D intermediary firms on the basis of semantic technologies and open standards. Finally, some research works in this field, such as that of [1], target

the efficient management of R&D projects in multilingual environments. Here, the authors propose an ontology-based methodology for the development of R&D project management systems with multilingual support. This methodology has been successfully applied in the development of a management system to facilitate R&D information which provides support for three different languages.

On a related note, a number of works focusing on project selection have appeared in the last few years. For instance, [19] discusses the use of the analytic network process (ANP) method to support the selection of projects in an R&D environment. More particularly, the authors make use of the ANP as a model to evaluate different R&D project proposals in order to provide actors with decisions and metrics. A different approach in the management and selection of R&D projects is the use of decision support systems (DSS), such as in Tian et al., 2005 [20–22]. For example, in Tian et al., 2005, the authors present a method for the selection of a suitable R&D project based on DSS. This approach accounts for the organisational aspect of the decision making process. In [20], an ontology-based text-mining approach with which to cluster research proposals is described. This approach automatically classifies English text documents into different discipline areas on the basis of their similarities. The work presented in [21], meanwhile, introduces an R&D project selection model. The model considers different interdependencies among projects and is based on linearization techniques. In [22], a mathematical formulation of the project selection problem is proposed. Here, the projects are ordered and prioritised using allocation rules through the use of an imbedded module which solves the resource-constrained project scheduling problem at each stage. Finally, the work described in [23] introduces a decision support system for investment in projects based on experts' evaluations. The method proposed combines the Kaufmann's expertons method, possibilistic discrimination analysis and the procedure for solving a bicriteria discrete optimisation problem.

In this manuscript, we propose a decision support system for R&D industrial project management. This decision support system assists in matching R&D projects with the funding calls that are best suited to the projects' characteristics and scientific proposal. It also helps in finding previous R&D projects that are similar to a given project. Our platform has been designed to be able to reuse and take advantage of existing vocabularies and ontologies such as FOAF and DOAP.

3. Platform architecture

The main aim of the system proposed here is to assist in the funding management of R&D projects at the knowledge level. On the one hand, the platform stores a semantic-based description of: (i) the R&D projects that are being carried out within the company, (ii) the R&D proposals derived from innovative ideas that require public funding, and (iii) the R&D public funding programmes and calls that are available. All this information is kept in the organisation's knowledge-based system which is implemented by using relational databases. The system leverages the semantic information gathered in a two-fold sense: (i) to assist in selecting the funding for new R&D proposals, and (ii) to perform general queries from the information available, thus producing precise and accurate results that can assist managers during the decision-making process.

The architecture of the platform is shown in Fig. 1. The system is based on previous works [24,25] and is composed of four main components: the semantic repository, the knowledge representation module, the R&D funding programmes and calls suggester and the semantic search module. In a nutshell, the system works as follows. The company's R&D projects and proposals and the

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