Formal Methodology and Reference Architecture for the integrated development of a tacit knowledge management system for virtual enterprises

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Abstract: - Knowledge management is nowadays one of the great research fields in which several philosophical and theoretical approaches have been proposed, and different technological solutions have also been developed and adapted with in it. However, knowledge management is a concept still evolving, and it faces serious difficulties when attempts are made to implement it in enterprises. The main cause of this situation is the lack of formal methodologies for guiding the process of development and application of this kind of systems. Moreover, there are few practical cases that can be taken as a reference and none at all when it comes to virtual enterprises. In this context, this paper outlines my PhD thesis proposal for describing this difficult situation, which is the origin of this research and the objectives suggested to solve it. The aim of the thesis is to develop a general methodology for directing the process of development and implementation of a Global Knowledge Management System (including the highly complex tacit part of it) in a virtual enterprise.

1 Introduction

This paper describes the background and objectives of my PhD thesis. It is organised in four sections. The first one shows the formulation of the problem. The second one presents the most significant problems within the field of research. The third one shows the suggested solution, in the form of an approach to the problem and the degree of innovation. Finally, the fourth section introduces the research methodology that was applied.

2 Problem Formulation

A Virtual Enterprise (or Extended Enterprise) can be considered as a temporary alliance of globally distributed enterprises which intervene in different phases of the life cycle of a product or service, sharing resources, skills and costs. To do so they draw on the new communication and information technologies in order to be able to better utilise market opportunities and design an efficient corporative strategy [1].

The need for knowledge management in an enterprise must not only consider the organisation internally but also externally, which entails analysing its relations with other enterprises and organisations. In this way, we can analyse and justify knowledge management in a virtual enterprise as a fundamental factor to support the new requirements in the market and obtain a competitive advantage.

The design and construction of a knowledge management system (KMS) in a virtual enterprise is a very complex process which includes different strategic, technological, human, organisational and knowledge management elements. Here, we are referring to tacit knowledge in the virtual enterprise. Such knowledge, after its transformation in accordance with the models and flows of the organisation's knowledge conversion management, becomes wholly explicit knowledge, which stimulates the sustainable growth of the organisation (i.e. both virtual and individual enterprises).

Consequently, most of the unsolved problems are in this domain, which is the core of all knowledge management systems, although in the domain of explicit knowledge management a lot of the problems have been solved but in a way that is not at all organised, strategic, formal or methodological.

This PhD thesis proposal lies within this latter complex framework, that is, tacit and global (integrated tacit and explicit) knowledge management systems, but more specifically within the virtual enterprise. Our objectives will be summarised in the development of a reference architecture and its associated methodology for the integrated and sustainable development of an enterprise system which allows management of tacit knowledge and its

application to the virtual enterprise. This framework will be arranged around the following elements:

- A methodology which manages the processes of development and implementation of a tacit knowledge management system within the virtual enterprise.
- A reference model that allows identification, representation and communication of the tacit knowledge inherent to the virtual enterprise.
- The extension of the ARDIN Reference Architecture for the integration of virtual enterprises defined by the IRIS research group. The aim of this is to extend the first of its dimensions to the methodology of integrated and sustainable development of a global knowledge management system within an enterprise.
- The design of a technological infrastructure as a support to store, process and distribute the tacit knowledge inside a virtual enterprise with the necessary security measurements.
- Guarantees of the quality, security and authenticity of the knowledge supplied in the virtual enterprise.

Finally, we will apply the specially designed methodology to a Virtual Tile Enterprise to test and validate the results it offers, and in turn this will allow us to reach a number of final conclusions.
Significant problems in the field of research

3   Significant Problems in the field of research

Knowledge management is nowadays one of the great research fields in which several philosophical and theoretical approaches have been proposed. Likewise, different technological solutions have also been developed and adapted to it. However, knowledge management is a concept that is still evolving, and serious difficulties arise when attempts are made to implement it in enterprises. The main cause of this situation is the **lack of formal methodologies** for guiding the process of development and implementation of this kind of systems. Moreover, there are few practical cases that can be taken as a reference and **none at all when it comes to the domain of tacit knowledge management in virtual enterprises**.

Formal theories and technological solutions have generally been applied, with varying degrees of success, in an independent manner in order to identify and transfer information and explicit knowledge (basically with documental support). However, the greatest complexity is to be found **in tacit knowledge**, that is to say, implicit knowledge, which is unspoken and located within relationships among people or teams, customers, suppliers, partners, owners or shareholders of different member organisations of the integrated virtual enterprise, etc. Below, we will call these sets of knowledge 'domains of knowledge'. It is this type of knowledge that will finally give the virtual enterprise its real competitive advantage.

It is important to understand that knowledge and information are different, and the new knowledge that is continuously being produced and developed in an organisation is not able to follow the same flow as that assigned to information. An example of this is the continuous problem found by enterprises in trying to draw meaningful knowledge from the collection of data contained within its information systems.

Other types of initiatives, techniques or actions therefore need to be applied. These may include, for example, making a source map of internal experience (which is little more than a DataWarehouse designed for information management and to enable localisation of the uncodified knowledge that exists in the organisation and which is normally embedded in experts' heads), creating networks of knowledge workers or establishing new managerial roles that have to do with knowledge management.

Consequently, (and this is the relevance of the research work presented in my thesis with all its results and which makes up my complete solution to the problem of the need for a reference architecture and a formal methodology to develop and design a tacit knowledge management system in a virtual enterprise) formal methodologies are urgently required to describe – step by step – the processes which shape the complete development and implementation of a global knowledge management system within an organisation, as well as its application to virtual enterprises, which, owing to their special features and interoperability, must allow [6]:

- Collection, identification and separation of knowledge and information.
- Storage of knowledge based on a common language.
- Making knowledge fully available to anybody in the organisation who needs it, provided they have the required authorisation to access such knowledge.

3.1 Purposes Statements on national and international initiatives and research programmes

The importance of knowledge management research is expressed, for example, in one of the seven areas of the European Union VI Framework Programme: "Civic and Government in the Knowledge Society". In addition, different fundamental actions concerning knowledge management are also defined in the other six thematic areas.

Moreover, a lot of interest has been shown in getting the European Union VI Framework Programme to include actions related to knowledge management in the virtual enterprise, like, for example, the statement made by the European Society of Concurrent Engineering.

In this area, the IRIS Group (Systems Integration and Re-Engineering) at the Universitat Jaume I has been working on different R&D and innovation projects related to virtual enterprises in different sectors since 1999 [8, 9, 10]. It is also currently directing the setup of a national thematic network on virtual enterprises in order to identify and map Spanish research groups working in this domain and, after that, to become the national node of a future European society.

My thesis has its origins, first of all, in the framework of a 'Ministerio de Ciencia y Tecnología' project entitled 'Knowledge Management in the Domain of Virtual Enterprises', which is currently being carried out. It is also based, however, on the European Excellence Network, 'INTEROP (Interoperability Research for Networked Enterprises Applications and Software)', which the IRIS group participates in.

4 Suggested solution: approach to the problem and innovation

To cope with the new market requirements, enterprises and especially the virtual SME need a formal methodology to achieve integrated and sustainable development using their tacit knowledge. They will therefore be able to confront the market environment with full guarantees of success while maintaining their essence, that is, their intangible knowledge, which is the source of the rest of the knowledge and information generated in corporative information systems.

This methodology, called vEKM (Virtual Enterprise Knowledge Management), is the objective of my PhD work. The suggested solution includes the definition of a reference architecture and its associated formal methodology in order to allow virtual enterprises to manage their business efficiently from a knowledge point of view. It is very important to note the large, complex problem of tacit knowledge as the centre and core of future interoperability problems.

My approach to this problem about knowledge management in virtual enterprises is organised around the following innovation actions:

- Integrate and introduce the principles, methods and tools related to knowledge management for the virtual enterprise.

- Analyse the theoretical and industrial requirements, and identify the critical functional characteristics of knowledge management for the virtual enterprise.

- Develop a formal methodology to obtain, share and transfer knowledge among the different member organisations that go to make up the virtual enterprise.

- Design a technological infrastructure as a support to the previously developed methodology so as to ease the implementation of knowledge management in the virtual enterprise and secure access to knowledge in a personalised way.

- Design change management, taking into account the resistance of human capital to the transfer of knowledge both into and out of their organisation. In general, this embraces all the aspects of knowledge that are not supported by any kind of technology.

- Apply the methodology so developed and the tools thus designed to the virtual enterprise. By so doing we will achieve correct validation and efficient improvement. All this is used to construct a thesis that develops a new knowledge management system (which includes the complex tacit aspect) and a prototype for use as an example of implementing a tacit knowledge management system in other types of enterprises.

5 Applied Research Methodology

My experience with information and knowledge management systems, team management, the application of e-business systems and e-commerce technology, the projects carried out throughout my time as a senior-consultant/junior-manager in Accenture and, finally, all my PhD studies conducted parallel to my professional career have enabled me to

carry out a complete study of the state of the art in the current research domain. To obtain the results, my thesis was developed using the incremental and iterative methodology outlined below, and which is organised in four different phases:

- Phase I: Review of the state of the art. Definition and input of new requirements.
- Phase II: Approach to/development of a reference architecture and methodology for the integrated and sustainable implementation of a global knowledge management system (including the tacit part as the most important aspect). Definition of an efficient integration strategy that enables results to be achieved.
- Phase III: Application of the methodology thus developed to different virtual enterprises.
- Phase IV: Validation and testing of the methodology, conclusions and future work.

6   Contributions of the applicant to the resolution of the problem: Goals and results achieved so far

The specific goals and results achieved in my thesis, which in fact are my contributions as an applicant to the complete resolution of the problem, are the following:

- Analytic study and review of current knowledge (state of the art) of the problem domain (concerning virtual enterprises), as well as the state of existing solutions, while also focusing strongly on the integration requirements of the virtual enterprise, its reference architecture and its management systems.

- Study of the state of the art of such knowledge models and management strategies in virtual enterprise that allow us to continue with the integration of our vEKM architecture in them. My thesis includes case studies of different projects in knowledge management and the state of the art in Communication and Information Technologies applied to the development of knowledge management systems.

- Definition of a Reference Architecture for the integrated development of a knowledge management system, which includes the necessary action framework and the associated organisational, technological, human, relational and cultural management aspects.

- Virtual Enterprise Analysis and Identification of Domains of Knowledge/Requirements.

- Development of a formal methodology, which is organised in different phases, to manage the development and implementation of a knowledge management system for virtual enterprises. The methodology considers different aspects like strategy definition, certain features of e-business (which are very important in the strategic and process areas), the associated process re-engineering, human resources management, the management of important changes and continuous improvement, and the information system supporting the knowledge management system, which is necessary to maintain the relations among the member organisations of the virtual enterprise and uses the Internet as a central intercommunication element.

- Definition and development of the formal methodology to manage, control and coordinate the development and implementation of the highly complex tacit part associated to the global (i.e. explicit and tacit) knowledge management system of the virtual enterprise. Here, first of all, it is very important to define knowledge and human capital management and control processes among virtual enterprise resources. It is also essential to design the associated relations the different member organisations of the virtual enterprise establish with their customers, suppliers and collaborating partners, as well as the administration and unions as elements that are external but which are very important to our objective in the global management system of the virtual enterprise.

- All this makes it necessary to define submethodologies like vEKM to customer knowledge management (CKM), business knowledge management (BKM) from the different member enterprises, suppliers and partners, and employee knowledge management (EKM), from the human resources internal to each member enterprise in the global virtual enterprise.

- Development of a final model of an integrated information system to support the suggested global knowledge management for the virtual enterprise. This model includes the current information technologies to enable us to achieve the results presented here. The is also a need for the description and design of the technological components and e-business strategy associated to

the development of each of its parts and relations, thus allowing automation of the information flows and relations with customers, suppliers and partners.

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