Definition of Target Knowledge in Virtual Enterprises

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Abstract

A virtual enterprise is a new organisational paradigm which requires novel technological approaches to managing data, information and knowledge in an efficient way. Knowledge management systems have been adopted as a solution to deal with enterprise systems which generate a huge amount of data, and also need to manage information in an appropriate manner and to share knowledge for decision-making. However, these systems are even more essential in the context of virtual enterprises, where business success is based on interoperability achieved by means of ICT, and therefore there is a need for a common conceptual framework that enables partners in the virtual enterprise to share data, information, and knowledge. Thus, the implementation of this kind of technologies in virtual enterprises demands new, more specific requirements. In this paper, we propose a conceptual framework that introduces the concept of target knowledge as a first step for implementing efficient knowledge management systems, and for further knowledge representation in the context of virtual enterprises. Finally, a classification of target knowledge defined taking into account several enterprise dimensions is provided.

1. Introduction

The global economy, customer orientation and the swift evolution of Information and Communication Technologies (ICT) are some of the factors that have produced a new economic scenario, where information and knowledge have became strategic resources for enterprises [1]. The virtual enterprise arises in this context as a new organisational paradigm in which valuable cooperation can be established among partners in order to exploit competitive advantages by sharing resources, skills and costs, and by establishing a new model of interoperability [2].

A virtual enterprise is a network of independent enterprises, often competitors, that form a temporary alliance with the aim of developing a product or service so as to be able to take advantage of new market opportunities and to make it easier to achieve their objectives by sharing resources and costs [3].

Traditional knowledge management systems have been introduced by enterprises as a good solution to enable them to share and distribute knowledge among their employees [4–6]. Nevertheless, in the context of virtual enterprises, where several partners with different procedures, methods, rules, culture and so on are integrated within a single virtual enterprise, the implementation of a knowledge management system is a far more complex task and it cannot be developed only by applying technological issues. Thus, a common conceptual framework that enables partners in a virtual enterprise to represent and to share data, information, and knowledge is needed before establishing a knowledge management system.

Such a framework should be focused on a holistic point of view of the enterprise and it is the basis for providing a common understanding about business for the partners that make up a virtual enterprise. In this paper, we present a set of knowledge requirements, called target knowledge, that are needed to develop this kind of systems. They are related to the KM-IRIS methodology [7], which has been developed by the IRIS Group in order to implement knowledge management systems in virtual enterprises.

The paper is organised as follows. Section 2 shows a review of the concepts related to knowledge framework and states the problems related to knowledge management systems within the context of the virtual enterprise. The knowledge management approach developed by the IRIS Group is briefly presented in section 3, as the framework in which the target knowledge is proposed. Section 4 describes the target knowledge defined within this approach, as well as the classification and analysis performed about it. Finally, section 5 outlines the conclusions.

2. Knowledge Perspective

The concept of knowledge has been defined from very different points of view, but in the field of enterprise information systems it has been usually linked to the concepts of data and information. In this section, we present some definitions of knowledge in order to provide a characterisation of enterprise knowledge as the basis for defining the target knowledge that is needed to implement knowledge management systems in the context of virtual enterprises. Moreover, a brief review of knowledge management systems, as well as the problems concerning the virtual enterprise are also detailed.

2.1. The Concept of Enterprise Knowledge

Data become information when they add value to the enterprise, and information becomes knowledge when insight, abstraction and a better understanding are added to it. Thus, knowledge can be defined as the capacity for effective action in a domain of human actions [8].

On the other hand, Nonaka [9] defines knowledge as the justified belief that increases the capacity of an entity for effective action. The conventional creation of knowledge is usually performed following the model in which data are transformed into information, and information is transformed into knowledge, but it can also follow the reverse model in which knowledge precedes information and data [8]. As a result, knowledge can be represented by means of links among data, information and knowledge inside a system, but other data, information and knowledge can also come from outside the system through other connections.

The process of converting this knowledge from the sources available to an organisation and then connecting people with that knowledge is one of the definitions provided to explain knowledge management [10, 11]. Furthermore, knowledge management facilitates creation, access and reuse of knowledge, typically by using advanced technology, such as the World Wide Web, Lotus Notes, the Internet and intranets [12].

According to [13] enterprise knowledge can been seen as information made actionable in a way that adds value to the enterprise. Taking into account this context, we defined enterprise knowledge as the network of connections among data and information that enables people involved in the enterprise to act and to make decisions that add value to the enterprise. Moreover, two dimensions can be defined in enterprise knowledge, explicit and tacit, following the current interpretation [5] that defines a fuzzy borderline between explicit and tacit knowledge.

2.2. Knowledge Representation

A knowledge management system is a specialised system that interacts with the organisation's systems to facilitate all aspects of knowledge engineering [4]. The benefits of Knowledge Management Systems are well-described in a great number of papers [14], many of which also deal with the context of virtual enterprises. In spite of different generations of knowledge management systems are described in [5], where it is also explained why they did not live up to the expectations they had aroused.

One of the weak points of these systems is the need to link conceptual framework with technological level, especially for knowledge representation. In [15], it is stated that knowledge representation is a multidisciplinary subject that needs to apply theories and techniques from logic, to provide formal structure and rules of inference; ontology, to define the kinds of things that exit in the

application domain; and computation, to support the applications that distinguish knowledge representation from pure philosophy.

Therefore, to communicate and distribute knowledge among the partners in a virtual enterprise not only technological approach is required. The definition of a common conceptual framework that enables partners to gain a common understanding about the business and goals of the virtual enterprise is also needed. The main problems in establishing this kind of systems in virtual enterprises are:

- The partners that make up a virtual enterprise implement different processes with distinct rules and procedures to perform the main activity of their businesses.
- The partners in a virtual enterprise usually have different types of nfrastructure, organisational structure, decisional units, and so forth.
- The success of each of the partners that make up a virtual enterprise is due to several factors, such as know-how, the use of resources, core skills, and so on.
- The data, notations, documents, and so forth managed by each partner are diverse and sometimes the same documents are used for different purposes.

3. Proposed Approach to Knowledge Management in Virtual Enterprises

The IRIS Research Group at the Universitat Jaume I in Castell´o (Spain) has been working on several projects related to the virtual enterprise in different sectors (transport, tile industry, textile, and so forth) since 1999 [16–18]. The main aim of these projects has been to define and apply an architecture, called ARDIN [16], capable of supporting the design and creation of a virtual enterprise in an integrated way.

Taking into account the problems mentioned above, the group's research is currently focused on adding a new dimension to the ARDIN architecture that enables knowledge to be compiled, managed, and applied within a virtual enterprise. The new dimension has been formally organised according to the following issues:

1. A methodology for directing the process of development and implementation of a knowledge management system in a virtual enterprise called KMIRIS [7].
2. A set of models to allow the identification, representation, and communication of the knowledge inherent to a virtual enterprise.
3. The design of a technological infrastructure that allows knowledge to be stored, processed, and distributed inside a virtual enterprise.

The results shown in this paper are concerned with the second of these issues, the aim of which is to identify what knowledge is useful to an enterprise in

general and to provide a conceptual framework that enables to represent enterprise knowledge.

4. Target Knowledge

In section 2, we have defined enterprise knowledge as actions that allow people to act and to make decisions with the result of adding value to the company. Each enterprise has its own vision, mission, and strategies and thus the knowledge that adds value to its business is different in each particular case. However, and bearing in mind that some common concepts are to be found in any enterprise, the framework proposed in this paper provides several conceptual blocks of knowledge defined according to the dimensions of enterprises in order to help them identify the most useful knowledge for them, that is to say, their target knowledge.

In this framework, the first grouping of distinct kinds of knowledge is called a conceptual block of knowledge. This first classification is made by identifying the big items related to the enterprise and on which it wishes to develop its knowledge management system, since these are the most interesting subjects that the enterprise needs to know in order to gain a deeper knowledge of its businesses and the capacity to improve them. Furthermore, the aim of improving knowledge management in the virtual enterprise by establishing a common conceptual knowledge framework that allows the knowledge representation is also considered.

The main conceptual blocks of knowledge defined in this framework are proposed, first, taking into account several enterprise dimensions (organisation, resources, process, and so forth) suggested in the context of Enterprise Modelling [19–21], and second the explicit and tacit dimensions of knowledge. This conceptual blocks of knowledge can be classified into two categories considering the two criteria above mentioned:

- **Enterprise oriented blocks**: the blocks defined are: organisation, process, product, and resource. They have their origin in the enterprise dimensions proposed in the context of Enterprise Modelling. These blocks are primary related to explicit knowledge. However, despite the use of the adjective 'explicit' it must be pointed out that in these blocks we can find both explicit and tacit target knowledge, since explicit and tacit knowledge are not two separate forms of knowledge, but instead inseparable, necessary components of all knowledge [22].
- **Human oriented blocks**: the blocks defined are: owner, supplier and customer, administration and trade union, and environment. They are originated in the tacit dimension of knowledge. At the same way in the previous case, we can find as tacit as explicit target knowledge in these blocks, however the most target knowledge defined within these blocks will be usually tacit knowledge.

The target knowledge presented in this paper are related to enterprise oriented blocks, and, despite the fact that each enterprise should identify its own target knowledge, they can be useful for enterprises like a pattern in the process of identifying their target knowledge for the conceptual block of knowledge above proposed. Therefore, in this section, we present a general definition of target knowledge with the objective of establishing a conceptual knowledge framework that allows for common understanding among the partners in a virtual enterprise - something that is needed before the implementation of its knowledge management system.

This definition is made from the user's point of view, taking into account, for each enterprise oriented block defined, the knowledge that partners need to improve the performance and interoperability of the virtual enterprise. The target knowledge for each block is defined in the following subsections.

4.1. Conceptual block of knowledge: ORGANISATION

This conceptual block details the knowledge about the structure of the organisation, providing different visions: administrative, systemic, and from the human resources point of view. Moreover, it captures the target structure, decisional structure and rules structure of the enterprise. Therefore, the target knowledge related to this block can be organised in four ontological categories as it is shown in Table 1.

4.2. Conceptual block of knowledge: PROCESS

This block provides knowledge on general issues about processes in enterprises such as ICOMs (Input, Control, Output, and Mechanisms), documents, rules, know-how, and so forth; and on flows (of work, documents, of material, and so on). Different levels of processes are then defined including decisional and collaborative processes. The ontological categories proposed for this block are shown in Table 2.

Table 1. Target knowledge for conceptual block of ORGANISATION

Ontological category	Target knowledge	Description
Target structure	Strategic level	To know which is the enterprise's vision and mission, and also to identify clearly which are the strategic objectives and strategy established in the enterprise in the long term to reach its mission.
	Tactic level	To know what decisions are taken and how resources are assigned in the medium term to follow the strategy defined at the strategic level.
	Operative level	To know how the enterprise's daily activities and operations are planned, coordinated and executed in the short term and who is in charge of these activities.
Organisational structure	Administrative view	To know first which is the structure from administrative and executive point of view taking into account the different kinds of virtual enterprises: in star, in network, ans so forth and, second, which is the organisation chart for individual enterprise as well as virtual enterprise.
	Human Resources view	To know which is the hierarchic organisation established in enterprise, defining the different levels that exist, that is to say, departmental units, departments, sections, and so on.
	System view	To know from a system point of view which are the systems identified in enterprise and which are its main functions and relationships.
Decisonal structure	Decisional centres	To know which is the structure of enterprise taking into account the decision taken by employees at distinct levels.
	Cost centres	To know enterprise's costs associated a each element that exists in enterprise to analyse them considering different clusters performed according to the strategy adopted.
Business rules	Lines of action	To know which are the main guidelines and directives of behaviour established in enterprise to achieve a good functioning of all elements involved in it.
	Rules	To know which are strict rules provided by the company in order to perform all the enterprise activities.

Table 2. Target knowledge for conceptual block of PROCESS

Ontological category	Target knowledge	Description
General	ICOMs	To know for each process which are the elements needed to perform a process, that is to say, the inputs needed and output obtained as well as the constraints and the mechanisms to carry out the process.
	Spliting of processes	To identify the main macroprocesses performed in enterprise and how they are divided into microprocesses, activities, tasks, and so on.
	Documents	To identify the primary documents that are used for each process, such as orders, delivery notes, invoices, and so forth.
	AS-IS and TO-BE views	To understand which is the current situation of enterprise processes and which should be the desired situation.
	Procedures	To know for each process the specific procedures that it is needed to perform in enterprise.
	Know-how	To identify specific, special skills and capabilities that enterprise has in each process.
	Cost	To analyse which are the costs linked to processes, and their profitability and added value for customers.
Flow	Of materials	To know the different ways in which the materials are transformed in enterprise and in which processes are involved these materials.
	Of data / information / knowledge	To know which are the main track that data run in enterprise to be transformed into information and knowledge, in order to identify the main mechanisms, techniques, and methods to obtain information and knowledge.
	Of decision / control	To understand step by step how decisions are taken in enterprise and they control the enterprise performance.
	Workflow	To know which is the sequence of the different tasks that make up one activity, and how they are carried out and by who.
	Of documents	To know which is the sequence and possibilities of transforming documents involved in processes and by means of what rules this transformation is performed.
Process level	Operative processes	To know which are the processes developed by enterprise at the operative level, realizing which are the core processes, in which enterprise is the leadership, which are the added value processes that add value to enterprise and to its products/services; and which are the supporting processes.
	Decisional processes	To know how the processes related to decision-making at the strategic, tactic and operational level are implemented.
	Collaborative processes	To know what are the processes that involve other partners of virtual enterprise and how they are carried out.

4.3. Conceptual block of knowledge: PRODUCT

The main knowledge about the products and/or services provided by the enterprise are described in this block, taking into account the process of achievement and marketing, the composition options, the quality, the cost and so forth. Thus, the target knowledge related to this block can be organised in five ontological categories as it is shown in Table 3[1].

Table 3. Target knowledge for conceptual block of PRODUCT

Ontological category	Target knowledge	Description
Generation process	Manufacturing	To identify which is the way to obtain the product in enterprise (manufacturing, assembly, project, an so forth) and to know the main features of the corresponding process to generate the product.
Composition	Bill of materials	To identify the components and materials needed to generate one product.
	Composition levels	To know the different levels of composition in which the product can be divided into.
	Optionality	To identify the possibilities of product configuration in order to provide customers different versions of the same product or the same product with distinct customisation, assembly or labeling.
Quality	Standards	To know the standards that are linked to products developed in enterprise.
	Documentation	To identify the documentation performed about quality product in enterprise and the main links with the other documentation generated in enterprise.
Marketing	Samples	To know which are the possibilities of offering samples of products to customers, identifying which are the more useful, more profitable, and so forth.
	Catalog	To identify which is the list of products with their references, main features, prices, special conditions, and so on.
	Advertisement	To understand which is enterprise's philosophy for advertisement and which are the main mechanisms of publicity that it uses in order to reach the planned objectives.
	Trademark	To identify which is the philosophy of trademark and which are the primary symbols to show it.
	Labels	To know the diverse possibilities of putting labels to products in order to customisation them taking into account customer's wishes.
Cost	Rough / After taxes	To analyse which are the costs as rough as after taxes related to products.
	Profitability	To classify products taking into account economical profitability of products developed by the enterprise.
	Added value for customers	To classify products according to the added value that they provide to customers.

4.4. Conceptual block of knowledge: RESOURCE

Knowledge about human resources and material resources is classified in this block into three main categories: location of these resources, potential use of them, and finally, the cost associated. The target knowledge related to human resources is shown in Table 4.

[1] The target knowledge is only shown for products, it would be really similar for services.

Table 4. Target knowledge for conceptual block of ORGANISATION

Ontological category	Target knowledge	Description
Location	Internal	To identify which are the human resources that enterprise has in order to perform its activities.
	Inter-enterprise	To identify other human resources that they belong to other partners in virtual enterprise and how they can be useful collaborating in the enterprise's tasks.
	External	To identify feasible human resources that they do not belong to enterprise, but that could be useful in the future to reach its objectives.
Potential	Availability	To know which is the availability of the external human resources in order to cover different jobs.
	Curriculum	To know which is the people's curriculum vitae involved in individual and virtual enterprise as well as external human resources' curriculum vitae.
	Knowledge	To analyse which are the main knowledge that people involved in enterprise have.
	Capacity	To know which is the volume of work with which people could contribute to perform the different enterprise processes.
	Ability	To analyse which is the main know-how about products, process and so forth that people involved in enterprise have.
	Experience	To classify people according to their experience in several knowledge categories and for solving different kind of problems.
Cost	Rough / After taxes	To analyse which are the costs as rough as after taxes related to human resources.
	Profitability	To know the economical profitability of human resources.
	Added value for customers	To know which are the human resources that provide an added value to customers.

4.5. Analysis of target knowledge

The target knowledge presented above can be classified, using the ontological categories provided in the previous tables, into several categories, which are defined from two points of views:

1. First, the Enterprise Modelling field [19–21], in which the intention is to analyse the enterprise from a holistic point of view and therefore several dimensions related to the enterprise [23], such as organisation, process, product, and so forth, are defined.
2. Second, Knowledge Learning theory, in which the way to learn is based on three issues: concepts, procedures, and attitudes.

The result of this classification can be seen in Table 5.

Table 5. Framework to classify target knowledge

	Organisation	Process	Product	Resource
Concepts	Target structure Organisational structure Decisional structure	General Process level	Composition Quality	Location Potential
Procedures	Business rules	Flows	Generation process Cost	Cost
Attitudes	Business rules		Marketing	

4.6. Conclusions

Knowledge management systems can be used in virtual enterprises in a similar way how they are used in an individual enterprise. However, the specific features of this new organisational paradigm requires the introduction of a conceptual

framework of knowledge, which enables the partners that make up a virtual enterprise to share the same concepts and to be more familiar with the other partners' procedures and attitudes, in order to implement an efficient knowledge management system.

In this paper, we have defined the target knowledge to establish this framework in a virtual enterprise, while considering each conceptual block of knowledge (enterprise oriented) proposed in the approach for knowledge management defined by IRIS Group, that is to say, organisation, process, product, and resource. The target knowledge defined has been classified taking into account two points of view, in order to provide a basis that can be used as a reference for further representation of knowledge by virtual enterprises that need to implement a knowledge management system.

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References

1. Kalpic, B., Bernus, P.: Business process modelling in industry–the powerful tool in enterprise management. Computers in Industry 47 (2002) 299–318
2. Kosanke, K.: Enterprise Inter- and Intraorganizational Integration, Building International Consensus. In: Proceedings of the ICEIMT'02 Conference. (2002) 3
3. Browne, J., Zhang, J.: Extended and virtual enterprises - similarities and differences. International Journal of Agile Management Systems 1/1 (1999) 30–36
4. Abdullah, M.S., Benest, I., Evans, A., Kimble, C.: Knowledge modelling techniques for developing knowledge management systems. In: 3rd European Conference on Knowledge Management. (2002) 15–25
5. Schutt, P.: The post-Nonaka Knowledge Management. Journal of Universal Computer Science 9 (2003) 451–462
6. Ramesh, B., Tiwana, A.: Supporting Collaborative Proccess Knowledge Management in New Product Development Teams. Decision Support Systems 27 (1999) 213–235
7. Chalmeta, R., Grangel, R., Fern´andez, V.: Methodology for the implementation of knowledge management systems. (2006) in evaluation.
8. Splieger, I.: Technology and Knowledge: bridging a 'generating' gap. Infomation and Management 40 (2003) 533–539
9. Nonaka, I., Takeuchi, H.: The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press (1995)
10. O'Leary, D.E., Kuokka, D., Plant, R.: Artificial Intelligence and Virtual Organizations. Communications of the ACM 40 (1997) 52–59
11. O'Leary, D.E.: Guest Editor's Introduction: Knowledge Management Systems: Converting and Connecting. IEEE Intelligent Systems 13 (1998) 30–33

12. Devedzic, V.: A survey of modern knowledge modeling techniques. Expert systems with applications 17 (1999) 275–294
13. Vail, E.F.: Knowledge mapping: getting started with knowledge management. Information Systems Management Fall (1999) 16–23
14. Liao, S.: Knowledge management technologies and applications - literature review from 1995 to 2002. Expert Systems with Applications 25 (2003) 155–164 Elsevier.
15. Sowa, J.F.: Knowledge Representation. Logical, Philosophical, and Computational Foundations. Books/Cole (2000)
16. Chalmeta, R., Grangel, R.: ARDIN extension for virtual enterprise integration. The Journal of Systems and Software 67 (2003) 141–152 Elsevier.
17. Chalmeta, R., Grangel, R., Ortiz, A., Poler, R.: Virtual Integration of the Tile Industry (VITI). In Jeusfeld, M., Pastor, O., eds.: Conceptual Modeling for Novel Application Domains. Volume 2814/2003 of Lecture Notes in Computer Science., Springer-Verlag (2003) 65–76
18. Chalmeta, R., Grangel, R.: Performance measurement systems for virtual enterprise integration. International Journal of Computer Integrated Manufacturing 18 (2005) 73–84 Taylor & Francis.
19. Vernadat, F.B.: Enterprise Modeling and Integration: Principles and Applications. Chapman and Hall (1996)
20. IFIP-IFAC: Generalised enterprise reference architecture and methodology (GERAM). Technical Report Version 1.6.3 (1999) http://www.cit.gu.edu.au/bernus/taskforce/geram/versions.
21. Lillehagen, F.M., Dehli, E., Fjeld, L., Krogstie, J., Jørgensen, H.D.: Utilizing Active Knowledge Models in an Infrastructure for Virtual Enterprises. In: PROVE. (2002) 353–360
22. Tsoukas, H.: The tyranny of light. Futures 29 (1997) 827–843
23. Grangel, R., Chalmeta, R., Schuster, S., na, I.P.: Exchange of Business Process Models using the POP* Meta-model. In: International Workshop on Enterprise and Networked Enterprises Interoperability (ENEI'2005). Volume 3812/2005 of Lecture Notes in Computer Science., Springer-Verlag (2005)