

Management of Information in Virtual Organisations Breeding Environments.
E. Ermilova

Abstract

To create more chances for capturing new opportunities in the market and society, organizations and in particular small and medium enterprises (SMEs) increasingly move toward collaboration with each other, through reaching larger set of competencies and resource capacities. The so-called Virtual Organizations (VOs) are then formed among autonomous organizations that are typically heterogeneous, autonomous, and geographically distributed. VOs are goal-oriented consortia, and typically dissolve after achieving their goals. With the purpose of optimising and facilitating effective / agile creation of VOs, in recent decades both research and practice have shown interest in pre-establishing a longer-term network / alliance of SMEs to serve as the base. Thus, the so-called Virtual organisations Breeding Environments (VBEs) are established for this purpose in a variety of domains, from manufacturing to elderly care, providing the common platform for SMEs to join, in order to prepare themselves for collaboration and reaching the level of readiness needed for effective formation of VOs.

VBEs can appear in different sizes and may reach thousands of geographically distributed members, willing to collaborate within VOs, and sharing their profits and losses, through the effective use of their combined competencies, capabilities, capacities and know how.

Management of the VBEs is challenging, and in need of designing better or new approaches and tools. Specifically, it is challenging to properly support: managing the operations of VBEs, supervising VBE members' activities, preparing VBE members for collaborating, facilitating VO brokers once they find and/or define an opportunity, as well as enabling agile / fluid formation of VOs composed of VBE members. During its life cycle, every VBE handles large varieties of data, information, and knowledge. However, the information and knowledge accumulated in VBEs should be commonly understood by all its stakeholders, and properly formatted and stored so that it can be effectively processed and analysed. Therefore, as a main element of the VBE management, advanced management of its information is required, as addressed by the research of this thesis.

Our research is focused on the design and development of an information management approach and system for the 2nd generation Virtual organisations Breeding Environments (VBEs). It addresses many of the challenges related to the creation of VBEs and their effective operation. As such, it first addresses the existing background of this area, the so-called 1st generation VBEs. It then identifies a set of problem areas and open questions to be targeted by our research. It especially introduces four high-level research challenges related to creation and operation of 2nd generation VBEs, including:

(i) Facilitating the common understanding of environmental concepts - Although 1st generation VBEs run for a few decades in some industries and specifically in manufacturing, there is still lack of generally accepted definitions for the generic VBE concepts. This in turn causes the lack of common understanding and effective communication of concepts among the VBE members. In practice, this problem becomes even more severe due to both the need for merging and interrelation of different types of generic concepts within the VBE, and the continuous and dynamic joining of new members/actors to the VBE, each bringing their own bag of new domain-dependent knowledge and terminology.

(ii) Effective assistance with the VBE instantiation in different sectors and domains - Every VBE instantiation case is costly and quite time/effort consuming. This is mostly due to the fact that every VBE at its creation step should establish, among others, a common ICT platform and infrastructure for its members' co-working, specific set of working and sharing principles, and a set of advanced

functionality for management and supervision of its members and their activities, etc., in order to perform its own supporting managerial activities, e.g. finding potential market opportunities for formation of VOs, and selection of the most fit group of partners for a VO, which are not straightforward.

(iii) Supporting the required dynamism and scalability of VBEs – In order to capture emerging opportunities in volatile markets, VBEs shall act dynamic and adaptive. This means also being open to continuously extending/adapting their membership and size, and customization and parameterization of functionality to match the specific emerged needs. Furthermore, the VBE administrator requires access to most up to date competency, capacity, etc. information related to both new and existing members. Developing semi-automated ICT-supported approaches and functionalities are required to adapt and facilitate these dynamic processes.

(iv) Boosting and balancing the involvement of VBE members in the VOs – Both the variety in kinds of information as well as the dynamism in features and abilities that represent each organization at the VBE, pose obstacles to acquiring such updated information for the purpose of organization's involvement in potential VOs. In small running VBEs, the VBE administrator might remember and be unofficially informed about all its members. But in the 2nd generation VBEs, the large size of the VBE adds further complexity to the above point, which further prevents VBEs from being able to provide fair chances for VO involvement to VBE organizations.

The approach and methodologies introduced in this thesis focus on tackling the above four challenges. It specifically first addresses the development and management of the VBE ontology, and second the expansion of one of its sub-ontologies, focused on organizations profile and competency. These elements are then implemented as two of the main components of the VBE management system.

The developed VBE-ontology addresses the challenge (i) above through defining the comprehensive set of VBE concepts, so that it can be shared in a uniform format, and commonly understood by the variety of VBE stakeholders. The VBE-ontology responds to the challenge (ii) above through serving as the common data model for development of distinct VBE databases in different sector/application, and specifically to be used for specification of VBE data classification, and parameterisation of VBE management tools. Furthermore, the VBE-ontology responds to the challenge (iii) above through provision of semantics, that can support semi-automated acquiring and management of VBE information, and in turn accelerating the information management processes of the VBEs. Finally, the VBE-ontology responds to the challenge (iv) above by providing means for formal and uniform representation of characteristic information related to the VBE members, such as their profiles and competencies, which can in turn support the balanced involvement of all its involved organisations in potential VOs. Furthermore, in order to comprehensively address the above challenges with ICT-based supporting tools, the thesis introduces and implements a system called the **ColOnto** (Collaborative networks Ontology) system, built on top of the VBE-ontology. As such, while the conceptual part of the ColOnto system represents the specification of the VBE-ontology itself, its functional part is composed of the set of functionalities that support the maintenance and management of the VBE-ontology.

The **main contributions** of this thesis are therefore twofold:

- The methodology applied for design and engineering of a unified ontology for VBEs, called the VBE-ontology is described. The VBE-ontology is specified. Furthermore, among the several partitions defined as sub-ontologies of the VBE-ontology, one main partition dedicated to the profiles and competencies of VBE member organisations, is detailed out and specified.

- An information management system and a set of specific functionalities to tackle the VBE-ontology are designed and developed. This system, called the Ontology Discovery and Management System (ODMS) introduces specific services to help both the VBE members in familiarising themselves with the VBE concepts, as well as the VBE administrator with management of operations and parameterising different VBE management sub-systems. One main component of the ODMS is another system called the VBE Profile and Competency Management System (PCMS). The PCMS in turn introduces the set of functionalities required for management of the profiles and competencies of different VBE actors.

Besides storage and viewing the ontology concepts, several other functionalities are implemented in the prototype of the ODMS, including: ontology modification, concept search, ontology-based text-mining, etc. Similarly, the prototype for the PCMS represents functionalities for storage and manipulation of both the VBE's profile and competency models and related information content, further to searching competencies and extraction of VBE's aggregated competencies, among others.

All our developments, i.e. the theoretical framework, the methodologies, and the prototypes, presented in the thesis, have gone through direct validation / evaluation procedure within the operational environments of four different running VBEs, and have generated positive results and better performance than alternative systems.

The work in this thesis is partially achieved within the context of the EC-funded integrated research project ECOLEAD, within which this research and its development and validation are achieved. Most concepts introduced in this thesis and its produced results are already published and presented to the research community, through several technical channels.