2 AN OUTLOOK OF FUTURE RESEARCH NEEDS ON NETWORKED ORGANIZATIONS

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The objective of this paper is to draft a possible outlook on future research in the area of networked organizations, given its evolution during the past decade. In those 10 years, focus shifted from supporting the flow of standard goods between multiple enterprises to supporting the delivery of one-of-a-kind goods or services by a temporary consortium of enterprises. The paper presents an overview of past research in the area, as well as a synopsis of the challenges researchers are currently dealing with. Three main challenges for businesses are reflected upon, namely sustainable collaboration, managing and taking advantages of complexity, and inter-enterprise creation and innovation.

1. INTRODUCTION

One of the trends in the global market is the increasing cooperation among enterprises during the entire product life cycle. This is related to business drivers, such as the need for cost reduction, flexibility, focus on core competencies, and so on. The result is anything from a rather stable alliance between partners as in a supply chain to a more transitory cooperation as in a virtual enterprise. The latter can be defined as a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose co-operation is supported by ICT (Camarinha-Matos, 2000). When the final product and/or service have been delivered, the virtual enterprise dissolves.

During the past decade, the amount of research in the topic of networked organizations has been – and still is – quite considerable. National funding organizations have provided the funds for many groups of researchers to advance the state-of-the-art in this domain. The European Union has been one of the largest supporters of research in this theme; through a succession of its Framework Programmes, it has supported dozens of research projects in Virtual Enterprises and accompanying areas.

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ten years, focus shifted from supporting the flow of standard goods between multiple enterprises to supporting the delivery of one-of-a-kind goods or services by a temporary consortium of enterprises, from supply chain management to inter-enterprise project management, from manufacturing to the full product life cycle, etc. This paper presents an overview of past research in the area, a synopsis of the challenges researchers are currently dealing with, as well as some needs for future research. Examples of past and present EU funded research projects are also given.

This paper is organized as follows. The next section gives an overview of the research in the area of supply chains and virtual enterprises during the past ten years. Section 3 presents an outline of present research in the area, and highlights the topics that get a lot of attention today. In section 4, some research needs that could potentially have an impact on networked organizations in the future are introduced. A discussion concludes this paper.

2. PAST RESEARCH

2.1 Past research in supply chains

Over the years, companies have continuously been busy re-shaping themselves, and have recently turned back to a sole focus on their core competences. This has led to increased outsourcing of activities that were not considered as core activities. Many tasks that used to be performed by the company itself were subsequently performed by specialized partners.

Whereas emphasis was on internal processes before, supply chain processes became the focus of bilateral process reengineering efforts in the 1990s. Internal integration into a process-oriented enterprise was followed by 'external' supply chain integration, linking together several supply chain members.

Research focused amongst others on eliminating the bull-whip effect. This effect, which was first described by Jay Forester (1961) in his pioneering works on system dynamics, is the result of the lack of coordination between logistics decisions by individual members of a supply chain. At its turn, the lack of coordination is due to insufficient visibility into the supply chain. This issue was addressed and to a large extent solved by ERP systems for enterprise-internal processes, but not for processes between different members of a supply chain. Even if companies look outside their own enterprises, they are inclined to optimize the relationships with their closest suppliers and customers in a one-to-one fashion. The bull-whip effect is just one of the symptoms of the lack of visibility throughout the supply chain, and is very well demonstrated via MIT's "beer game" (ETHZ, 2004).

A report on the portfolio of EU funded research projects in the area of Smart Organizations found a broad range of technologies, themes, and business sectors (Camarinha-Matos *et al*., 2002). Examples of a long list of EU funded research projects addressing supply chain management aspects are Adrenalin, Chainfeed, Co-operate, and Smartisan. Adrenalin dealt with multi-party supply chain management in networked enterprises (Brehmer and Martinetz, 2001). Chainfeed aimed to develop process modeling tools (Hunt *et al.,* 2000). Co-operate concentrated on the coordination of manufacturing planning and control in the supply network. Smartisan aimed to develop a generic XML based service to facilitate easy access

and search to a range of systems, and support synchronized delivery of extended products against deadlines in the wholesale and retail sectors (Oliveira *et al.,* 2001).

2.2 Past research in virtual enterprises

In the past decade, the focus of research gradually shifted from supporting a rather stable alliance between partners as in a supply chain to supporting more temporary cooperation as in a virtual enterprise.

Figure 1 shows the basic concepts of 'enterprise networks' and 'virtual enterprises'. A virtual enterprise (VE) can be characterized as an inter-enterprise business cooperation where individual enterprises join core competencies in order to establish a value chain that is configured exactly to meet a specific customer demand. When the customer demand has been fulfilled, the virtual enterprise is decommissioned. The virtual enterprise is therefore highly agile compared to conventional, rigid supply chains. A virtual enterprise can be considered as a means to achieve economy-of-scale advantages for companies that specialize in certain competencies, as it provides them with the opportunity to exploit their expertise in several consortia. Though the VE is made up by different professionals and competencies from various partners, it operates as one, unified, and synchronized enterprise, hence its virtual nature. Accordingly, the business processes are not carried out by a single enterprise, but every enterprise is a node in the VE that adds some value to the chain.

Virtual enterprises are 'set up' from enterprise networks. These networks are made up of numerous individual enterprises that jointly are available to exploit business opportunities through setting up virtual enterprises. The main purpose of a network is to prepare VEs. It establishes mutual agreements among its members on issues such as common standards, business processes, procedures, intellectual property rights, cooperation agreements, and ICT, so that these time-consuming preparations can be significantly shortened when a customer request arrives, and a VE is put in place. The network should be seen as a portfolio of core competencies and as a breeding environment from which different VEs can be established in order to satisfy different customer demands. This competence portfolio is dynamic in the
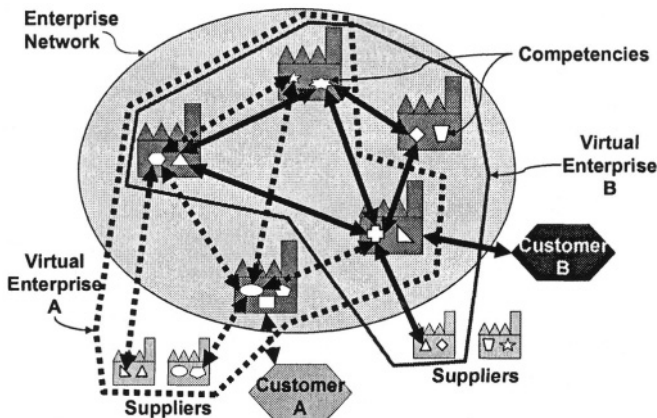

Figure 1 – Enterprise Network and Virtual Enterprises

sense that competencies can join or leave the network.

One should clearly distinguish an enterprise network and a virtual enterprise. In a network, there is no notion of a specific product, project, or contract. On the other hand, the VE is set up with a specific purpose in mind, i.e. a specific contract specifies the delivery of a specific product or service to a known customer. Compared to a virtual enterprise, a network can be perceived as a relatively long-term cooperation since it typically sets up multiple VEs.

Research topics in the area of virtual enterprises focused (amongst others) on inter-enterprise project management, collaboration services, and mediators. Inter-enterprise project management should lead to:

- More reliable project plans, via a shared model of project activities and requirements,
- Better project monitoring, via on-line access to project status, with real-time notification of events and 'alert' conditions and with impact evaluation for deviations based on changes of downstream activities,
- A decrease in project risk, via clear visibility of the status of activities for all partners in the VE,
- Higher flexibility and efficiency, via a faster response to customer change requests, through better leveraging of partners from the network potential and accelerating and controlling the flow of information during the project lifecycle (Berg *et al.,* 2003).

Communication platforms and collaboration services focus on the underlying infrastructure for virtual enterprises. Such platforms and infrastructures should provide communication and integration services, community management including modeling relationships among enterprises, and support for workflow. On top of these infrastructures, applications are needed for the monitoring, management, and optimization of the multi-enterprise collaboration.

Mediators are an almost natural consequence of the concept of setting up virtual enterprises out of networks of individual enterprises. Specialized organizations – the mediators – could play a role in this setup process, but also in the management of the network itself. These mediators should know the competencies of individual enterprises in the network, could act as the entry point for potential customers, could set up and manage the VE, and could provide collaboration services, and so on.

The same report on the portfolio of EU funded research projects mentioned above provides many examples of EU funded research projects in this area (Camarinha-Matos *et al.,* 2002). Another overview is given by the project Voster (2004). Examples of each of the three topics mentioned above are Whales, Globemen, and Business Architect. Whales aimed to provide a planning and management infrastructure for complex distributed organizations working as virtual enterprises on large-scale engineering projects (Gazzotti *et al.,* 2001). Globemen tried to define a reference architecture for virtual manufacturing enterprises, to implement proof of concept industrial prototypes, and to demonstrate core features of the architecture. See (Busschbach *et al.,* 2002) for an example of a Globemen paper on infrastructure. Business Architect drafted a new business development service with the same name as the project, which should take the lead in formulating and communicating business opportunities, looking for partners in an enterprise network, and facilitating strategy building and operational planning (Aston *et al.,* 2001).

3. CURRENT RESEARCH

Current research in the area of networked organizations can be characterized by a number of focal points. This paper mentions a few of the more obvious focal points in the current key EU funded projects in this area, namely the theoretical foundation, the 'suitability for deployment', and the interoperability and security aspects.

There is a need to define a theoretical foundation for the VE research area. In the past, many prototypes for inter-enterprise project management and infrastructure services were developed. Whereas a lot of resources were spent on such prototypes, attention for models and methodologies that should provide the foundation for these VE related applications, was relatively minor. In addition, more and more importance is attached to the enterprise network as the breeding environment for setting up virtual enterprises. The preparation requirements within the network are starting to be researched. Finally, there is evidence that socio-economic trends impact the way enterprise networks behave and virtual enterprises are formed and managed; an example of such a trend is the rise of Professional Virtual Communities. These trends lead to new ways of thinking about virtual enterprises, and therefore the theoretical basis of the domain needs to be established and continuously updated.

In addition to a theoretical foundation, research needs to be carried out to make the virtual enterprise concepts more deployable. An instrument for this could be the definition of reference models for inter-enterprise business processes. Reference models should take into account various types of industries and industry segments, and differences in business models, e.g. different manners and degrees of outsourcing, the existence or absence of service providers, and so on. Furthermore, SMEs often have difficulties in deploying the VE concepts and technologies, and to join an enterprise network or business ecosystem. For the latter, it is not sufficient to simply model SMEs and the services they provide. SMEs need to be modeled in the context of their business relationships and interactions with other SMEs.

The issue of interoperability of business processes and enterprise applications was relevant within one organization, but is even more relevant in networked organizations. Participants in a VE desire to have diverse local solutions that better suit their unique local conditions. Every enterprise, although willing to cooperate and interoperate with others in order to fulfil the common goals of the collaboration, insists on preserving its rights to local choices and solutions, on protecting its proprietary information, and on the provision of special access rights to a part of its information only to those other enterprises that either it can trust or it is obliged to provide information by contract. This causes a tension between the obvious needs for cooperation among organizations (which would call for adoption of some common standards), and the suitability of certain proprietary solutions that can more readily meet local conditions. In other words, even if there are global standards sufficient for every business need, there will always be incompatible systems out there – either by choice or because of legacy.

Finally, in an environment where different legal entities exchange information, they need to be able to rely on secure exchange of information, which is not the case at the moment. There is a need for an architecture that enables the secure execution

of collaborative business processes within virtual enterprises. In addition, software tools need to be developed, and methods and resources need to be defined that assist in the effective implementation and operation of software and systems instantiating the architecture.

Current EU funded research in the networked organizations area is characterized by a concentration of ambition, efforts, and resources. A new instrument, the Integrated Project, is used to achieve a critical mass in order to achieve impact, integration, and excellence in research. An Integrated Project (IP) should have the potential to influence and/or change the domain and the market. Since the research area is still quite fragmented, an IP should concentrate its research and build critical mass by involving other actors in the domain. Finally, excellence in research should be achieved by clear progress beyond state-of-the-art and the integration of both scientific and industrial research competencies. Four Integrated Projects have started around January 2004, namely Athena, Digital Business Ecosystems, Ecolead, and Trustcom. They are expected to cover the focal points mentioned above.

4. POSSIBLE FUTURE RESEARCH

In today's business environment, enterprises collaborate with each other for efficiency reasons mostly, and it is not likely that this will change within the next couple of years. Enterprises are working in networks rather than as standalone organizations. This trend happens in all industrial sectors for one main purpose, namely to improve the supply chains. The currently recognized main benefits in improving the supply chains are cost reductions in terms of logistics management and customer management. Nowadays, this is seen as one of the most evident benefits of the use of ICT in industry (Porter, 2001).

Tomorrow's picture (2010 and beyond) might show sustainable collaboration for more than cost reduction and productivity improvement reasons only. The "next big thing" in collaboration could be not to address productivity costs but to stimulate the collective creation and innovation processes within networks of businesses which will never happen in case these organizations are not fully collaborating. This level of collaboration implies that all participants accept to share part of their knowledge with other businesses that they trust. Note that in the literature on value disciplines, a change of focus from costs to innovation would mean a change of value discipline from operational excellence to product leadership (Treacy and Wiersema, 1995).

The global business environment will be characterized by an increase of complexity and turbulence. Coping with this increase of complexity, businesses will be faced with another major challenge, namely the transformation of their traditional form, structure, and operational practices to be more robust and able to adapt to a continuously changing environment. Organizational boundaries will become more blurred (e.g. communities of practice are already becoming operational in many sectors). Control mechanisms based on cause-effect relationships are not fully effective anymore where unpredictable behavior could emerge.

Given the above, many areas of future research are possible. In this paper, three main challenges for businesses are reflected upon, namely sustainable collaboration, managing and taking advantages of complexity, and inter-enterprise creation and innovation. Each of these challenges demands for future research.

For sustainable collaboration, research is needed that addresses accompanying business models and business processes. Models and methodologies need to be developed to set up and operate networks through the availability of collaborative platforms and mechanisms that allow organizations to easily participate in multiple networks. This is already addressed to some extent in the second focal point of current research mentioned above. Furthermore, the success – or the lack thereof – of networked organizations needs to be measured and evaluated. A specific performance measurement framework should be developed. Not only should the performance of networked organizations versus traditional organizations be evaluated, but also the performance of an organization within an enterprise network.

Research is needed to address the management of complexity in networks. There is a need to analyze turbulent environments in specific industrial sectors in order to better understand the drivers of turbulence and the responses of various industry players to this turbulence. Here the concepts of Complex Adaptive Systems (see e.g. (Waldrop, 1992)) and Multi Agent Systems could be relevant. These concepts are quite appealing, since the analogy with enterprise networks and virtual enterprises is quite obvious. However, although known, the application of these concepts into practice in general, and in the field of networked organizations in specific is a research issue. The move from largely descriptive analysis to prescriptive applications still needs to be made. For example, whereas in Complex Adaptive Systems endless trial and error and survival of the fittest eventually leads to stable surviving systems, it is not a suitable approach for – for instance – mediators in enterprise networks who aim for a predetermined objective in a predictable time.

Finally, there are research challenges that address innovation in enterprise networks. For example, it is not clear how innovation related to products and processes could be stimulated and managed in inter-organizational networks. Different specialists from different members of an enterprise network could work together on new products, and manufacturing and service organizations could play a role as well. Such networked organizations need to operate with state-of-the-art technology, under time-to-market pressures, and with continuing new product introductions. Companies that deliver state-of-the-art technology will always face the challenge of complexity. Knowledge sharing gets very important since this is an instrument to overcome this complexity. Furthermore, it is not clear how networked organizations should manage the tension between creativity and efficiency, and still maintain an ongoing dynamic balance.

5. DISCUSSION

Leveraging the differences that distinguish Europe from other large economies has become an integral part of research and technology development efforts taking place with the support of the European community. It is not surprising that research into aspects and technologies enabling virtual enterprises raises considerable interest among European researchers and economists, since Europe is likely to gain from it most. Europe's multi-cultural and multi-lingual society, sensitive to an inclusive society, characterized by a rich landscape of small and medium-sized enterprises, offers the ideal conditions which will enable and nurture innovative business models such as the concepts exposed in this paper.

Research in networked businesses should cover various points of view. Whereas the EU funded programmes are strongly focused on the technology point of view, research is needed that also covers for instance the socio-economic, human, and business process view points. Development of technology should always be done within the business context of networked organizations, thereby taking into account all relevant stakeholders.

Whereas progress achieved in some EU funded projects is considerable, one should always take into consideration what happens outside this context, both in other research projects and in industry. Although the total amount of resources spent on EU funded projects is large, it represents less than 5% of all publicly funded research in the European Union. Therefore, new research projects and the Integrated Projects in particular should take into account other relevant research projects, and leverage on their results. Furthermore, industry is leading the way in many domains, for instance the application of agent technology and RFID in supply chain processes. Researchers in networked organizations should be aware of this.

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