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Challenges of Virtuality from the Viewpoint of SMEs

Raija HALONEN, Päivi ISKANIUS
CISC, National University of Ireland, Galway
& Department of Information Processing Science, University of Oulu, Finland,
Email: raija.halonen@oulu.fi
University of Oulu, Raahe Unit, Rantakatu 5, 92100 Raahe, Finland
Email: paivi.iskanius@oulu.fi

Abstract: This study analyses the collaboration in the context of small and medium size enterprises (SMEs). The paper approaches the research topic with a case study of fourteen manufacturing SMEs. In order to develop a collaborative network, companies need to develop their information and communication (ICT) capabilities and networking skills. To take a full advantage of collaboration, the companies have first to redesign and implement their own information sharing systems, such as enterprise resource planning (ERP) systems. This study examines the challenges and risks that may arise in the ERP implementation when building a virtual space for collaboration. Also, the current state of art is presented and scenarios are built of how to develop virtuality further.

1. Introduction

Manufacturing companies face an unprecedented process of change in their business environment, characterised by globalisation, international competition, technological complexity, and increasing customer orientation, which are replacing the traditional cost/quality/time business excellence variables with new views, such as agility and rapid innovation. To fulfill market demands, companies have to increase product portfolio, reduce time-to-market, shorten product-life cycles, and produce high quality products with quick response, lower costs, and greater customization [1]. Increasingly, companies focus on their core competences and collaborate with other organisations with complementary knowledge and resources [2], [3]. The competitive advantage of collaboration arises from five sources: mutual learning, a strategy of cospecialisation, better information and resource flows, economic of scale and organising market structure with network members [4], [5].

An interesting project to meet the goal of getting advantage from collaboration is called eBusiness Watch that aims to support the goals of European Commission by studying and assessing the impact of information and communication technology (ICT) on enterprises, industries and the economy in general; by highlighting obstacles for ICT uptake, for example issues that form barriers to a more effective use of ICT in European enterprises; by identifying and discussing public policy challenges that ground on the observed developments at the European level; and by engaging in dialogue with stakeholders from industry and policy institutions.[6] Modern ICT, such as the internet and web technologies, significantly increase firms’ capacity to efficiently generate and process knowledge-based information [7]. ICT also reduces the importance of geographical location; it makes it easier for firms to reach partners, expand their customer base, launch new products into global markets, rationalise their businesses, and renew their business models [8], [9], [10]. To take a full advantage of collaboration, companies have to redesign their information sharing systems, such as enterprise resource planning (ERP) systems. ERP systems, when...
successfully implemented, link all functions of an organisation including order management, manufacturing, human resources, financial systems, and distribution with external suppliers and customers into a tight integrated system with shared data and visibility [11].

Small and medium size enterprises (SMEs) must find new organisational solutions that allow them to cope with global business opportunities without suffering the effects of their size and limited human and financial resources [12]. The participation in a collaborative network has the potential of bringing benefits to the involved companies. These benefits include, among others, acquisition of a larger dimension, access to new or wider markets and new knowledge, sharing of risks and resources, joining of complementary skills and capacities which allow each firm to focus on its core competencies while keeping a high level of agility and rapid innovation, and thus creation of new value, by confrontation of ideas and practices, combination of resources and technologies, and creation of synergies [13]. Even ICT offer SMEs significant opportunities to grow and to compete, SMEs typically use ERP systems for the finance/accounting functions, and many advanced features, such as production planning and scheduling, typically have not been explored [14]. While for example European Commission has tried to promote European competitiveness through e-business policies actively since 2003 [15], there still is lack of academic research on practical actions towards e-collaboration between SMEs. This research adds to the gap by revealing the state of adopting virtual collaboration in SMEs in the steel manufacturing industry.

2. Objective of the Study

This study analyses the collaboration in the context of SMEs. The study examines the possibilities to build a virtual space for collaboration. The paper approaches the research topic with a case study of fourteen manufacturing SMEs. Even if the case companies operate in slow-moving steel manufacturing industry, their business environment has become more fast-paced and unstable. The trend in their business is towards more value-added products, total solutions that are customised to the individual customer needs, and the case companies have to strengthen their core competences and build strategic relationships with other companies. In order to develop a collaborative network, companies need to develop their own ICT capabilities and networking skills, and implement new ICT systems, such as ERP systems. The primary motive for ERP implementations is the potential for enhancing the firm’s competitiveness. ERP systems provide significant benefits, and companies adopted them with the goal of replacing inefficient stand-alone legacy systems, increasing communications between business functions, increasing information processing efficiencies, improving customer relations, and improving overall decision making [14].

While Lesjak and Vehovar [16] note the benefits of eBusiness Watch that monitors e-business activities in the European Union, they highlight the need of special interpretation when evaluating the experienced problems with e-business implementation. Implementing ERP systems in the collaborative network is an entirely different preposition than implementing an ERP system in a single enterprise environment. Collaborative companies have to integrate between their ERP packages and other applications such as legacy systems and e-commerce sites. This study examines the challenges and risks of various issues that may arise in the ERP implementation in building a virtual space for collaboration. Also, the current state of art is presented and scenarios are built of how to develop virtuality further.

3. Methodology

To address the research theme, research methods that include conceptual theoretical deliberation and interpretation of empirical research material were utilised. The theoretical
material was explored and key features were identified. The empirical research material was collected with a questionnaire that was sent to carefully chosen enterprises. The specific web questionnaire was designed to find out the current state of ICT capabilities and skills, the ERP use in SMEs, and the maturity of virtual collaboration. The survey included questions related to organisational performance and business processes; problems in electronic data transfer; experiences of ERP use and benefits and risks to implement them. In addition, the survey includes questions of future development plans of companies.

The research problem is converged with the help of a case study [17], [18] and a conceptual-theoretical approach that is appropriate especially in research topics such as operation management, quality and strategy [19]. The case was reported bearing in mind the idea of van der Blonk who states that cases are written with a purpose that heads to the goal of the research project [20].

4. Developing Virtuality

4.1 Collaborative Networks

A variety of collaboration forms, which encourages sharing of information and knowledge among its members, are being developed, that is, ‘e-business models’ [21], ‘e-business networks’ [22], ‘e-business communities’ [23], ‘web-communities’ [24], [25], ‘virtual clusters’ [23], ‘virtual innovation networks’[26], ‘virtual enterprises’ [27], ‘agile enterprise’ [28], ‘value nets’ [29], ‘value webs’ [30], ‘value chain constellations’ [31], ‘information hubs’ [32], and ‘collaborative networks’ [33]. Empowered by the digital media, these virtual forms are expected to take the leading role in economic and social innovations in the world of increasing globalisation, connectivity and knowledge intensity [6], [34]. Collaborative networks are expected to produce benefits such as agility to recognise, react and cope with the unpredictable changes in the business environment; to create complementary roles that allow the partners to participate in competitive business opportunities; and to achieve dimension in the mode of critical mass and to appear in the market with a larger size [47]. Furthermore, collaborative networks aim to generate competitiveness due to proper division of subtasks among cooperating organisations and timely response by rapidly get the necessary competencies and resources; to resource optimisation by sharing infrastructures, knowledge and business risks; and to develop innovation due to the network that opens the opportunities for the exchange and confrontation of ideas [33]. Particularly for SMEs, participation in such a collaborative network has several benefits, e.g. acquisition of a large dimension, access to new or wider markets and new knowledge, sharing of risks and resources, joining complementary skills and capacities which allow each entity to focus on its core competencies while keeping a high level of agility, innovation, and value creation [35]. Companies assemble themselves based on cost-effectiveness and product uniqueness without regard to organisation size, geographic location, computing environments, technologies deployed, or processes implemented.

When developing a collaborative network, the partner selection is essential [37] as it influences all the future collaboration [33]. While Fischer et al. [37] highlight the need to improve production flexibility by collaborating; they also highlight problems due to the SME specific manufacture of products. Adding to that, Lau and Wong [38] contemplate partner selection in relation to handling the value chain activities. Correspondingly, Wu and Su [39] note that a virtual network has to be configured according to market opportunities and partners should be chosen keeping in mind success factors such as cost, quality, trust, and delivery time. Hackney et al. [40] note the significance of having the right mix of partners involved. They also underline the need of common schemas, models, motives and
ways of work to cooperate, and trust among the members in a network [40]. They conclude that inter-organisational networks are facilitated by knowledge sharing for supply chain capacity building and consolidation uncompetitive environments and continue that the opportunity to cooperate is motivated through trust and business sense-making. However, as the main strength of a virtual network lies in the range of competencies that the partners deliver jointly through remote collaboration, Jermol et al. [41] note how joint work adds to the complexity of the knowledge management. Furthermore, successful use of inter-organisational information system includes deeper and wider penetration of relations between enterprises, not only transactions that are supported by electronic ordering systems and markets [42]. Adding to that, Weisenfeld et al. [43] note the organisational interface problems that appear more complicated than technical interface problems due to the people who are involved with their personal objectives and the differing organisational goals in the collaboration. Burn et al. [44] explain how the degree to which virtuality can be applied in the organisations relates to the extent to which factors such as market interactions, knowledge management, competency and information and communication technology are aligned in the partner organisations. In their explanation, each factor has phases that describe their value and emphasis. Burn et al. [44] point out that the highest level consists of electronic consultative commerce, community expertise, collaboration and intranet value chain, respectively.

4.2 ICT Use in Building Virtual Spaces for Collaboration

The success of collaboration depends on intensive information sharing, and it is enabled by modern ICT systems, which makes business information transparent, seamless and easily accessible at any time and at any place [36]. Especially Internet and mobile network technologies have offered users, developers and businesses new possibilities to communicate and coordinate their operations in the collaborative network [45]. Also agent technology has been recognized as a promising approach for manufacturing enterprise integration as it provides flexibility and problems solving services [46], [47]. Current technological developments hold also some promise for small companies, for example Voice-over-IP telephony and mobile e-business solutions. Moreover, ICT companies are increasingly addressing the SME market by developing affordable, smaller-sized solutions, e.g. ERP suits [48].

With ICT systems, companies can enhance efficiency by providing real-time information regarding product availability, inventory level, shipment status, and production requirements, and the facilitation of collaborative planning among the network members by sharing information on demand forecasts and production schedules that dictate enterprise activities [46], [47]. ICT systems reshape business processes so that they have the potential to facilitate the information flow between processes across the network, and guarantee the accessibility of instantaneous and consistent information across all members of supply chain [50]. They reduce the product development time to market, reduce the product delivery time to the customer, improve workforce capabilities and flexibility, enhance the flexibility of the product facilities, and improve understanding and control of production processes [51]. Also, ICT can lead to radical changes in business organisations, not only within the enterprise, but also between companies and with customers [47].

Enterprise resource planning (ERP) systems are enterprise-wide software packages that provide fully integrated business processes with shared data and visibility, and thereby hold the potential of greatly enhancing organizational performance and establishing competitive advantage [52]. They can be regarded as one of the most innovative developments in the information technology of the 1990s. ERP systems have become popular especially among large corporations, as a total enterprise-wide application. ERP systems, when successfully
assimilated into an enterprise, can provide both operational and strategic benefits, and enforce a discipline of best practice and consultancy. ERP systems can significantly improve information flow, streamline processes and hence develop the enterprise's efficiency and its competitive advantage. [53], [54] While ERP systems cannot be considered as right tools for collaborative planning as such, e.g. Stine indicates that different ERP systems can be linked together, namely for example new agent technology solutions have been emerged to link different ICT systems, including ERP systems, together [46]. Also, even without a system, a company can join to collaborative network [46], [47].

5. Business Case Description

5.1 Case SMEs

Case companies operate in the time of constant changes, where new structures of different business fields are still forming. Companies seek after integration, effectiveness and speed over entire production network. This applies to new business modes, contracts and ICT solutions, as well as management systems. Since products and solutions are increasingly made directly to customers’ needs and according their own specifications, companies become more specialized both internally and between each other. As the field of operation has become more complex, ERP system has returned to the basic questions: managing the capacities, resources, stock, material resource planning, and logistics. According to survey analysis, case companies need to do following tasks electronically:

- Sending and receiving tenders and invitations for tenders. Controlled transparency needed to be taken into account (the invitation for tender to be sent to all companies or to selective ones only);
- Changing of tendering data into order data to be possible for the network members;
- Sending work orders to all member firms simultaneously;
- Follow-up of production process in different firms within the network in real time;
- Centralized documentation handling (quotations, orders, etc.);
- Reservation of free resources through the system. Resources meaning persons, equipment or services;
- Providing usage reports for the firms: volumes of usage, usage times, used services, change management, etc.

5.2 Challenges and Risk of the ERP Implementation

In the survey, the case companies were expected to choose out of 19 alternatives the most significant factors they require from ERP systems. The alternatives were assessed on the scale ‘insignificant’, ‘some significance’, ‘significant’ and ‘very significant’. Based on the replies, there were six alternatives to which ten companies answered ‘significant’ or ‘very significant’. Of these alternatives, integrating operations, eliminating unproductive work and enhancing process monitoring are related to increasing cost-effectiveness. Factors related to quality and quality improvement was considered as the primary development target. Process monitoring, and sourcing and sharing information were also raised as significant development targets of ERP. Insignificant factors as regards the development of ERP were change and improving change management, reducing the time-to-market, reducing the number of terms, expanding the product range, and reducing the costs of product development.

The case companies had several different and different-aged ICT systems in function. While new ERP systems are often expensive, companies want to receive all possible
benefits that even a poor system could produce. New ICT/ERP systems were usually acquired as off-the-shelf software packages, which were often purchased from different suppliers, that meant that they included multiple, overlapping system modules that performed the same tasks. Utilising same information and same database in different ICT systems could successfully be done only in two case companies. The other companies could not utilise the information in different systems at all, or that they could do it only partially. Different ICT/ERP systems or modules had similar properties, and they partly overlapped in 45.5% of enterprises. None of the case companies had automatic information exchange between them and their subcontractors’ or clients’ systems, and only one enterprise had partial exchange. The greatest problems of current operational mode and information processing aroused from data transfer. In 33.3% of companies, the necessary information was not transferred between various IT/ERP systems. In addition, the case companies reported the lack of the users’ knowledge/education. Maintaining the various systems was also seen as a reasonable problem in nine (64%) case enterprises. The main problems of ERP use were lack of adequate planning information, ineffective project steering systems, piled-up work, up-to-date load information, material-related operations, lack of a functioning ERP system, material resource planning, up-to-date information exchange/relevance between planning and production, changes in delivery times made by customers, and availability of material resources.

The case companies were also asked, what central development operations they were going to execute in the near future (1-2 years). In the near future, all of the companies were planning to execute development operations to improve production quality. They expected ERP systems to provide assistance in their quality improvement processes. Another important development target was to improve machinery and tools. According to most of the respondents, management development projects would take place later. The respondents viewed customer relationship management important, and ten of them considered it as a near-future development target. The most important issues related with the expectations for ERPs were finding and sharing information in a dispersed environment; standardizing operational processes; improving planning procedures; increasing customer-based tailoring; digitalization of documents; reducing the time-to-market; managing change processes and decreasing costs; and eliminating unproductive work.

The case companies were asked to assess the level of risks produced by ERP solutions to their business processes on the scale ‘great’, ‘reasonable’ and ‘small’. Ten of companies considered the impacts of system breakdowns and malfunctions on their customers as the greatest risks. Six of the companies considered operation failures resulting from technical difficulties as a great risk. The companies viewed as small risks chaining of production, dependence on other organizations, and loosing a contract because they had a wrong kind of an ICT system, or they did not have one at all. The aforementioned risks as well as other risks resulting from cooperation relationships were typical in subcontracting companies. Another risk factor was the lack of IT competence. Often, users and developers did not have time or competence to implement an ERP system. This risk was actualized in one of the respondent enterprises. Resistance to change was also a risk factor. The existence of change resistance was acknowledged in the case enterprises and could clearly be seen in the survey.

6. Conclusion

Prior research reveals that collaborative networks are a common way to do business today [3], [4]. Besides describing benefits, the literature review also exposes several challenges that virtuality sets to the network partners in the collaboration. However, despite the topicality of the issue, there is only little academic research done in the early phases of adopting virtual collaboration in the mode of shared information systems. Adding to that,
European Commission has launched a collaboration project eBusiness Watch [6] to support the adoption of ICT in enterprises. While its reports provide a wide overall picture, it does not reveal the challenges experienced by SMEs in manufacturing industry when heading to e-Collaboration. However, with the competition in today’s business getting harder, also SMEs face need to make structural changes in their business. Successful and profitable business nowadays demands collaboration between individual companies. Therefore the ability to manage and to share inter-organisational information is in a key role in achieving advantage over competitors. Inter-organisational collaboration also requires supporting ICT solution, such as an ERP system. The emerging development of ICT and specially the infrastructure of the Internet have further enabled new possibilities to share and exchange information in SMEs. Even if it seems that ERP systems are not suitable for formation of a collaborative network mainly because they are not planned to support inter-organisational collaborative efforts [53], [54], the fact is that companies have different ERP systems, which have been bought with 5-10 years’ life cycle in mind. That means that a solution should be found to link different ERP systems together. Further, our study also suggests that implementation of ERPs is the first step towards virtuality.

Even though the case companies seemed to be in the early stages of adopting the virtual network principles, the need for virtuality is highly recognised. At present, 50 % of companies have ERP systems. Almost all ERP systems work independently as self-point solutions. Furthermore, when faced with a new problem to be solved, advanced technologies of databases, mastered by the partners, make it possible to find complementary expertise needed but unavailable within the current network (see [42]). A collaborative network with the technical aid of these technologies and with the networked people will be able to recognize potential partners and invite them to cooperate whenever reasonable. Therefore, this study suggests that the SMEs build a database to include information about available experiences to be used across organizational borders. When updating the database the participants keep themselves aware both of their own competences and their partners’ competences. This study also suggests that the SMEs realise their virtuality as a portal that would be targeted both for the customers and the companies and enable access to their database (see [41]). Added to the database with available resources the portal acts as a realistic step towards concrete collaboration in a virtual enterprise (VE) (Table 1).

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<th>1st step</th>
<th>Adding and improving interaction between the SMEs</th>
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<td>2nd step</td>
<td>Joint portal</td>
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<td>3rd step</td>
<td>Database of available resources</td>
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Table 1 – First Steps Towards a VE

As the empirical material revealed the concern of sharing sensitive information with other companies, our study suggests that the first step towards virtuality would be the building of mutual trust between the proposed collaborative network parties. That would be followed by building up a joint portal that would also serve as a good marketing possibility for the SMEs. Companies have applied electronic data interchange in their marketing. The current study proposes that the third step would include building a database that would include such resources that could easily be shared in the involved parties, including e.g. logistics, see Table 1. Camarinha-Matos and Afsarmanesh [13] suggest further research on horizontal infrastructures for virtuality with the focus on generic, inter-operable, pervasive, low-cost and user-friendly infrastructures. In addition, they list challenges such as management of virtual enterprise environments, creation frameworks, trust, and negotiation. Camarinha-Matos and Afsarmanesh [13] also argue that the responses to the challenges cannot be separated from the socio-economic, organisational and business models issues. Therefore they recommend additional multidisciplinary research in the field.
This paper responds to their recommendation with the empirical cases that gave new information about the stage in SMEs that currently acted independently without any agreed formal collaboration.

According to experiences collected in this study, it has clearly come out that there is a lot of work to be done; not only in the developing the technology but also in the clarifying the working model of the collaborative network and fortifying the trust between companies. However, the positive results motivate the continuation of the development towards virtuality.

References