

COMPETITIVENESS OF FINNISH MANUFACTURING NETWORKS: CHALLENGES AND RECOMMENDATIONS

Mikko Koho, Timo Salmi, Juha-Pekka Anttila

*VTT Technical Research Centre of Finland
Espoo, Finland*

mikko.koho@vtt.fi

This paper reports the initial results and suggestions of a research project focusing on the competitiveness and efficiency of Finland's manufacturing industry and networks. Radical changes in structure and operation of supply chains and manufacturing networks pose grand challenges to both OEMs and subcontractors. Based on literature reviews, interviews, surveys and expert workshops, this paper reports and outlines solutions for the key challenges that were identified in relation to competitiveness, efficiency and manufacturability in Finnish manufacturing networks and supply chains.

Keywords: Competitiveness, efficiency, manufacturability, manufacturing, network

1. INTRODUCTION

Supply chains and manufacturing networks have experienced radical structural and operational changes over the last decade. The key reason for this is the greater focus placed by OEM companies on their core competences, and on outsourcing and/or offshoring manufacturing work and phases of the supply chain that were previously conducted in-house. With the decrease of the role of the single company in the delivery process, competition currently takes place between supply chains rather than between OEMs. OEM companies now have more complex, e.g. longer and more dispersed, supply chains and manufacturing networks to control and operate, and outsourcing has made them more reliant on their suppliers. For suppliers and subcontractors, globalisation and offshoring result in fiercer and more global competition. The recent trend of OEMs placing heavy emphasis on purchasing price and manufacturing costs has also increased the pressure and cost competition faced by Finnish subcontracting companies, resulting in loss of manufacturing jobs and an increase in unemployment rates through offshoring. This development has raised concerns over the competitiveness and prospects of Finnish subcontracting companies and manufacturing industry. Scenarios developed by the Boston Consulting Group, for example, expect Finland to lose 42,000 manufacturing jobs by 2020. The reasons include declining cost competitiveness in Finland and lower labour costs in Eastern Europe and Asia, as well as a small domestic market and increasing demand in emerging markets (Alsèn et al., 2013).

This paper presents the progress and initial results of an on-going VERA (Structural change in networked manufacturing) research project initiated on the basis of the observations and background discussed above. The project seeks to support the competitiveness and success of Finnish manufacturing industry, companies and networks. Particular focus is on the SME-sized subcontracting companies that play an important role in national manufacturing industry and the entire economy. To support the competitiveness of manufacturing companies and industry, the research project intended first to clarify the challenges faced by Finnish OEMs, suppliers and networks, and then to identify or develop suggestions and solutions for overcoming them. Changes in the market place and in manufacturing networks were seen to generate challenges for several areas of management and operation of the networks and processes. Initial assumptions and observations pointed to a significant potential for improvement in the processes and operations of supply chains. Examples of this include unnecessary,

repeated and overlapping work between OEMs and suppliers, and loss of information and knowledge within the network. The research project then set out to clarify the challenges and their causes, and to seek structural and operational concepts and models for overcoming them and improving competitiveness.

The paper is structured as follows: Section 2 elaborates on the background of the research project by discussing the trends, changes and challenges connected with supply chains and manufacturing networks. Section 3 focuses on the objectives, process and methods of the VERA project, and Sections 4 and 5 present the initial findings and results and discuss the further work needed.

2. TRENDS, CHANGES AND RELATED CHALLENGES OF MANUFACTURING NETWORKS

Trends in recent years in the structure and operation of supply chains and the changes that have taken place have given rise to significant challenges for manufacturing companies and networks. The most important trends and changes are seen to be related to outsourcing and offshoring by OEM companies, and to buyer-supplier relationships.

2.1. Outsourcing and offshoring

According to Bengtsson (2008), outsourcing means externalising manufacturing activities to external supplier companies, while offshoring refers to sourcing from an internal or external supplier located abroad. Motives for outsourcing include reducing costs, for example by taking advantage of suppliers' economy of scale, releasing resources and avoiding or minimising investments. At a more strategic level, motives and objectives include focusing on the core competencies of a company and gaining access to new competencies. (Bengtsson, 2008; Baden-Fuller et al., 2000; Kakabadse and Kakabadse, 2005) Advantages sought by offshoring include reduced costs, increased revenue, and gaining access to overseas markets (Meixell et al., 2005).

The effects of outsourcing and offshoring on the structure and management of manufacturing networks are various. Outsourcing increases the number of companies in the network, and hence its complexity. Previously intra-organisational processes and activities become inter-organisational, making management more challenging and convoluted. A typical challenge resulting from outsourcing is the physical separation of product development and manufacturing, which makes it more difficult to take manufacturing and manufacturability into account in product development and design. Offshoring then adds the international and global aspect to the manufacturing network and its management. Meixell et al. (2005), for example, state that according to several experts global supply chains are more difficult to manage than domestic ones, due to different cultures, languages and practices, and substantial geographical distances. Outsourcing and offshoring thus make manufacturing networks more dispersed, complex and difficult to manage. This affects and generates challenges especially to the OEMs. For suppliers, offshoring clearly increases competition, especially in terms of manufacturing cost and price. In countries such as Finland, where labour costs are relatively high, this is a sizeable challenge, and a threat to the success and competitiveness of supplier companies.

Outsourcing and offshoring also affect the capabilities and performance of the manufacturing network. From the OEM perspective, outsourcing creates the risk of losing critical skills, capabilities and knowledge related, for example, to manufacturing and product development (Bengtsson, 2008; Lonsdale, 1999). With regard to the performance and success of a manufacturing network, many authors (see e.g. Chen and Paulraj, 2004) highlight the importance of efficient and effective inter-organisational communication, and the integration of suppliers into product and process development. For a network rendered complex and dispersed by outsourcing and offshoring, realisation of these aspects is clearly a huge challenge. Furthermore, the overall effects of outsourcing and offshoring on network performance are far from clear or straightforward. Dabhilkar et al. (2009) report that outsourcing can have a positive or negative effect on performance. Bengtsson (2008), on the other hand, mentions studies that report no significant connection between outsourcing and performance, and also refers to McIvor (2005) and a report stating that only 5% of the firms surveyed achieved significant benefits from outsourcing.

In Finland, OEM companies have been active in outsourcing and offshoring their manufacturing work and activities. Although outsourcing provides opportunities for Finnish suppliers and subcontracting companies, offshoring has brought them major challenges and threats. Partly motivated by potential global markets and customers, offshoring nevertheless seems to be driven mostly by lower labour costs and purchasing prices. Finnish subcontractors are thus faced with fierce price competition, and are struggling to justify their

competitiveness to – and win orders from – OEMs, for example by means of flexibility, shorter delivery time and easier collaboration.

2.2. Buyer-supplier relationship

Significant and important changes have also occurred in buyer-supplier relationships. Outsourcing has increased the dependence of OEMs on their suppliers, as an industrial company will typically spend 50–85% of its turnover on purchased goods. This highlights the importance and effect of the buyer-supplier relationship and collaboration on the performance and competitiveness of supply chains. (Momme, 2002; Cammish and Keough, 1991) Several authors report that in the 1990s and at the beginning of the 21st century there was a clear trend towards reducing the number of suppliers, and focusing on long-term partnerships and close collaboration between buyer and supplier (Momme, 2002; Chen and Paulraj, 2004). The aim was to obtain cost reductions in the supply chain, to improve planning and control of the supplier base and processes, and to better exploit the competencies and innovation ability of the suppliers (KPMG, 2000).

This trend of close collaboration and long-term partnerships with local suppliers was also witnessed in Finland. Since – or due to – the recessions in the early 21st century, however, there seems to be a shift back to so-called ‘traditional’ supply management (De Toni and Nassimbeni, 1999; Jackson, 1985), characterised by short-term relationships and cost/price bidding competition. This has increased the volume of offshore sourcing, and resulted in fierce global competition and a declining demand for Finnish subcontractors. De Toni and Nassimbeni (1999) point out that the short-term focus and multiple sourcing strategy of traditional supply management make supplier involvement and collaboration in product and process development more difficult than in long-term collaborative relationships. Similarly, realising effective intra-organisational communication is more difficult in short- than in long-term collaboration. These issues can have a negative effect on the performance of the network, as discussed in the previous section.

3. OBJECTIVES, PROCESS AND METHODS OF THE RESEARCH PROJECT

The on-going VERA research project focuses on the structure, management and performance of Finnish manufacturing networks. The project is based on assumptions and observations that these are currently far from optimal, due to the changes and challenges already discussed, and that there is significant potential for improvement. In more detail, the key observations and assumptions were:

- lack of and challenges in information sharing and communication
- problems of work scheduling and resource utilisation
- excessive inventories
- poor responsiveness and flexibility
- poor manufacturability and lack of or challenges in its development.

All these clearly limit and reduce the performance and competitiveness of manufacturing networks. The VERA research project therefore set out to solve and overcome these challenges. The main research questions for the project are:

- With what kind of structural and operational concept(s) and model(s) can Finnish manufacturing industry, companies and networks be globally competitive?
- How should OEMs and suppliers operate in order to be successful in both the short and long term?

Based on the challenges and improvement needs identified, the initial themes or focus areas of the project were defined as: the role and operation of the sourcing and purchasing function, information sharing and management, and joint development. The models and concepts developed in the research project should cover these areas or themes and propose solutions for them.

The research project was divided into main phases as follows:

1. Clarifying the current state and future scenarios of manufacturing companies and networks
2. Identifying challenges and solutions related to organisation and operation of manufacturing networks
3. Evaluating, validating and improving the proposed solutions with manufacturing companies.

In the first two phases of the project, literature reviews, interviews, surveys and expert workshops were used to collect, analyse and synthesise data. Earlier research projects carried out by VTT and their results provided an

overview and a starting point for the research project. A literature review was also carried out, focusing on the structure, organisation, management and operation of supply chains and manufacturing networks. The major effort in data collection for identifying challenges and potential solutions was semi-structured theme interviews. These were conducted with 11 OEMs, seven subcontractors and two research and development organisations. The loose structure of these interviews was found to be suitable and beneficial for the purpose in giving researchers the opportunity to direct the interview based on its progress within the predefined themes (e.g. Hirsjärvi and Hurme, 2001; Sociology Central). In addition to the interviews, data was collected through a survey sent to 18 subcontractors. The questions, together with the results of the survey, are presented in Section 4.1. The survey's main purpose was to increase the number of companies involved in the review of the current state of manufacturing networks and the challenges faced. Both interview and survey covered the following themes:

- Sourcing and purchasing organisation and practices, and OEM-supplier relationship
- Order-delivery process and its efficiency
- Information and communication
- Collaboration in product and process development
- Future perspective and trends.

Referring to Section 2, the themes are quite similar to those presented in the literature on supply chain and manufacturing network management (e.g. Chen and Paulraj, 2004). Apart from the interviews and the survey, further data and opinions were collected from expert workshops, which were used also in analysing and synthesising the collected data.

In the third phase of the project, the solutions developed and the recommendations will be evaluated and tested with Finnish manufacturing companies and networks. The aim is to validate, and to improve, the results of the research project. This phase belongs to the planned future work of the research project.

4. CHALLENGES TO COMPETITIVENESS, EFFICIENCY AND MANUFACTURABILITY IN MANUFACTURING NETWORKS – AND RECOMMENDATIONS

This section presents the initial findings of the VERA project. First, an overview of the challenges to manufacturing networks is presented based on the survey. These are then elaborated and discussed in more detail on the basis of the interviews. Finally, theses or recommendations that pave the way towards solving the identified challenges are presented.

4.1. Challenges identified in the survey

The survey consisted of the following questions or propositions which the respondents were asked to answer. A 5-point scale was used, with 1 meaning “completely disagree” and 5 meaning “completely agree”.

1. Sourcing and purchasing practices of OEMs support the network's operation and efficiency
2. Efficiency of order-delivery process between OEM and supplier has been developed and achieved
3. Information flow and communication methods in the network are efficient and effective: useful and necessary information is available in a timely manner
4. Manufacturing network and supply chain are jointly developed by OEMs and suppliers to achieve overall efficiency
5. Manufacturability of products has been jointly developed by OEM and supplier
6. OEM and supplier trust each other
7. The future of Finnish manufacturing, especially subcontracting, looks better and brighter than the present

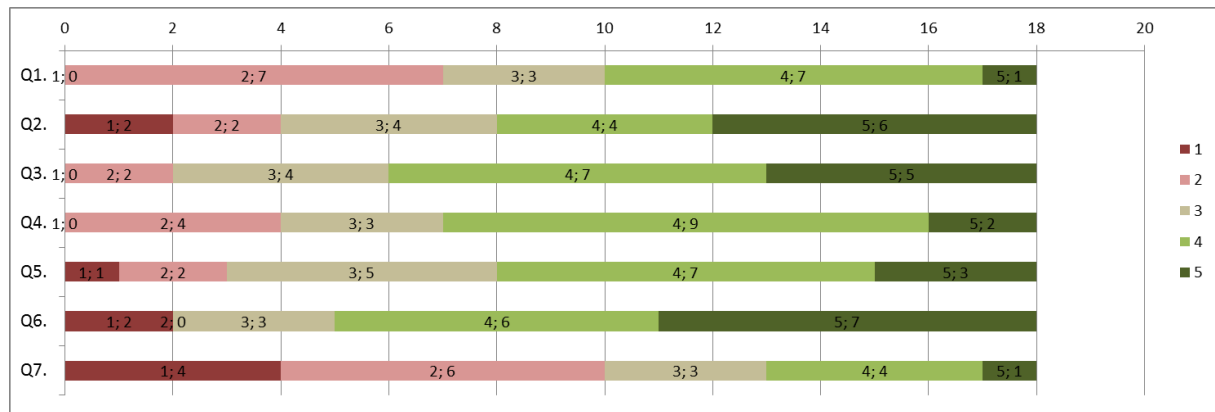


Fig. 1. Survey results: number of responses to the seven questions presented on a 1 to 5 scale (n=18, 1=completely disagree, 5=completely agree).

Figure 1 summarises the results of the survey. To the mild surprise of the researchers, the overview shows the majority of respondents agreeing either partially or completely with the propositions presented. The only exception related to the prospects of Finnish manufacturing industry and subcontracting, which were perceived as more difficult and challenging than at present. However, the result can also be interpreted to indicate the existence of improvement potential and need in all the areas or topics covered. This interpretation is supported by the comments made by the respondents during the survey. Most respondents mentioned that the situation varies widely among their customers: for some, co-operation and the current situation is healthy, while for others there is a clear need for change and improvement. In such cases, the typical answer was a neutral ‘3’, which hides the improvement potential as well as the efficient supplier-buyer relationships. When considering the themes and areas of the survey, the greatest potential for improvement appears to lie in developing the sourcing and purchasing practices that support the operation and efficiency of the entire network. Clear potential for improvement was also identified in developing and improving the efficiency of the order-delivery process between OEM and supplier, and in the joint development of products and processes. On the other hand, the trust between the suppliers and the OEM, and information and communication, seem to require less attention and changes.

4.2. Challenges pointed out in the interviews

In the interviews, challenges, i.e. improvement potential and need, were identified in all the themes and topics covered. These are briefly presented and discussed here.

Sourcing and purchasing organisation and practices, and OEM-supplier relationship. The interviews confirmed the existence of both long-term, collaborative relationships and more short-term, price and bidding focused buyer-supplier relationships in Finnish manufacturing industry. Some subcontractors voiced a concern that OEMs are emphasising the latter and moving back to the so-called ‘traditional’ operation mode. From the subcontractors’ perspective, purchasing price was seen as the dominant factor in decision-making, coupled with an inability to consider total costs. This was viewed as unfavourable for Finnish subcontractors, both due to relatively high labour costs in Finland and because of the relative difficulty of using longer-term, joint-development benefits as justification for competitiveness.

Issues related to contracts and sourcing and purchasing objectives were also raised in the interviews. Regarding contracts, some unjust contract practices were pointed out, with extended payment times from OEMs to suppliers, heavy sanctions and a low level of commitment for the OEM mentioned as examples. Regarding the objectives and practices of the sourcing and purchasing function, one often-mentioned issue was the objective or requirement to source a certain percentage from low- or best-cost countries. This was seen to force the buyers towards offshoring even where competitive local suppliers were available.

Order-delivery process and its efficiency. According to the interviews, joint efforts have been made over the last 5 to 10 years by OEMs and suppliers to develop and improve the order-delivery processes and its efficiency. These efforts were also seen to have provided good results. Opinions regarding the need and potential for further improvement were diverse: some argued that waste is generated and can be removed in each phase of the process, while others identified no significant improvement needs. More specific challenges were seen as managing and controlling the entire supply chain and manufacturing network, extending the development efforts

beyond the first tier suppliers, and simplifying, standardising and automating tasks and practices within the order-delivery process.

Information and communication. As an overview, the principle of having the right information in the right place at the right time was seen to be realised reasonably well, although some potential for improvement was pointed out. The key challenges included communicating product- and process-related changes in the network, communication beyond the first tier suppliers, and realising a seamless flow of information especially across company interfaces in the supply chain. Some respondents also argued for an improvement in accuracy and usefulness of the information provided.

Collaboration in product and process development. In general, the attitude of both OEMs and subcontractors towards a joint-development and collaboration in product and process development was positive. The perception was that a “two-digit” percentage improvement, for example in cost, could be achieved in this way. In comparison, the price bidding and competition approach was seen to provide only single-digit improvement. There was some divergence of opinion, however, over the current situation. Some subcontractors mention that there is little collaboration with OEMs, and that for subcontractors the development efforts of OEMs are neither visible nor tangible. Others, however, report successful joint development, with practical examples and good results. By contrast, some OEMs hoped for more action, suggestions and effort from subcontractors, and reported in turn that suppliers’ development actions were neither clear nor visible to them.

Future perspective and trends. The interviews provided insight into both the general market trends and more specific prospects related to Finnish OEMs and subcontractors.

At the general level, market growth and potential markets for both OEMs and subcontractors are expected to be abroad rather than in Finland. For the OEMs, the likely trend was seen to be in offshoring production to locations closer to the growing and potential markets. The trend of offshore sourcing from low-cost countries for manufacture in Finland was also expected to continue. Apart from the Asian countries, Eastern Europe too was seen as a potential source of materials and components. No let up was foreseen in the rapid, unpredictable changes both in demand and in the economy overall. Regarding global competition, the price and cost competition was expected to continue and intensify while the required delivery time for products shortens.

While seeking new sources of materials and components, OEMs nevertheless continue to regard local suppliers and subcontractors as important. Possible roles and prospects for local national subcontractors and supply chains were seen to lie in low-volume/high-mix production, fast and flexible deliveries, specialisation in terms or materials, product and manufacturing technology, focus on less labour-intensive automated production, and the utilisation of new, high technology. Regarding competitiveness and potential markets, it was pointed out that Finnish companies and networks could serve the European markets, while competitiveness and success in global markets such as Asia was viewed as less likely.

4.3. Theses and recommendations

On the basis of the observations and results, an initial set of theses and recommendations was formulated for Finnish manufacturing companies – OEMs and subcontractors – and networks. These summarise the observations and provide guidelines on improving the performance, competitiveness and success of Finnish manufacturing networks. The theses and recommendations also provide the reasoning behind the need for change and development. However, they are not intended to answer the question “How do we improve and change?” In other words, they contain no actual, practical development actions, nor do they offer new process and operational models. This forms a separate part of the research project. The initial theses and their brief descriptions are:

A manufacturing network and its networked companies should focus on, improve and optimise the entire network and its performance. The more detailed description and key points of this include:

- Operation and development of the manufacturing network and its processes must aim at the key objectives of manufacturing and the network
- Operation of the network must be beneficial and profitable to all members
- Strategies and operations of the companies should support and focus on total optimisation of the network
- Manufacturability and its development offers significant benefits to the manufacturing network.

Emphasis is on the importance of considering and developing the entire network rather than single companies. In the operation and development of manufacturing networks and processes, all the key objectives should be considered. These include cost, lead and delivery time, quality, flexibility and reliability (e.g. Koho, 2010; Bellgran and Säftsen, 2010; Miltenburg, 2005; Slack and Lewis, 2002; Wheelwright, 1984). For Finnish manufacturing companies and networks, high flexibility and rapid and reliable delivery are often the most important aspects and objectives, on account of cost competition in the global context being frustrated by high Finnish wage levels. The second point stresses that in order to be sustainable and profitable in the long term, the operation of the network must be beneficial to all its members. This is related for example to sharing the costs and benefits of operations and development. The third point states that to realise the collaboration and joint development of the entire network, those objectives must be highlighted in the strategies and permeate to the everyday decision-making of each company. Finally, as a more specific topic of collaboration and development, manufacturability is emphasised because of the high potential for improvement identified in that area. Manufacturability is related to the ease and efficiency of manufacturing a product, and requires collaboration between R&D and manufacturing in product design and development.

Buyer-supplier relationships should aim at collaboration and utilising the capabilities of suppliers. This thesis and recommendation can be elaborated with the following points:

- Development and optimisation of the entire manufacturing network must be carried out jointly and in collaboration between the buyer and the suppliers
- Trust between the buyer and the supplier is a key enabler of collaboration and joint development and should thus be emphasised, aimed for and developed
- Sourcing and purchasing and their practices have a key role in enabling collaboration, joint development and total optimisation of the manufacturing network.

This thesis and recommendation focuses on the buyer-supplier relationship and, as the first bullet point shows, is closely linked to the previous thesis. Trust is identified as the key enabler and prerequisite of collaboration and long-term joint development. Attention is also drawn to the important role of the sourcing and purchasing function as an interface between buyer and supplier.

Companies must improve their competences and performance by developing and investing in their key capabilities. Here the focus is on the companies in the network, and the aim is to encourage them towards continuous development of their capabilities and competences. In this way, companies can improve competitiveness, ensure and strengthen their role in the network, and improve the network's competitiveness. The capabilities considered can be further divided into more concrete areas and topics, such as:

- Technological capabilities, e.g., manufacturing equipment and methods, digital and information and communication technologies
- Process capability, i.e. efficiency and effectiveness of processes, and quality of processes and products
- Skills and capabilities of employees
- Organisation and management capabilities, e.g., how processes, operations and employees are organised and managed.

In general, the theses and recommendations emphasise the collaboration and joint development of companies in a network. These are seen to enable significant improvements in the performance and competitiveness of Finnish manufacturing networks. A close, longer-term collaboration is expected to be beneficial for both OEMs and subcontractors. It is viewed as essential and especially important for Finnish suppliers because of the difficulties in equalling, let alone outperforming, their global competitors in short-term cost and price competition.

5. SUMMARY AND DIRECTIONS FOR FURTHER RESEARCH

This paper presented the progress and initial results of an on-going research project aimed at supporting the competitiveness and success of Finnish manufacturing industry, companies and networks. The current situation, key challenges and future outlook for the Finnish manufacturing companies, networks and industry were clarified and summarised by means of a questionnaire survey and semi-structured interviews. An initial set of theses and recommendations providing ideas and guidelines for improving the performance and competitiveness of Finnish manufacturing networks was presented on the basis of the overview and understanding gained.

To summarise the results, the key challenges were related to the sub-optimisation of the manufacturing network, short-term buyer-supplier relationships focused on bidding, and the manufacturability of products. Concern over the future of Finnish manufacturing companies and industry was clearly evident. The theses and recommendations presented aim at solving the challenges identified, and thus emphasise improvement and optimisation of the entire manufacturing network, joint development and improvement of manufacturability by companies in the network, and collaborative, long-term buyer-supplier relationships. The importance of continuous improvement, development and investment in the capabilities and competences of each firm was also pointed out.

The further work planned includes elaborating on the presented theses and recommendations, and developing them towards more concrete solutions and suggestions. This should lead to the ultimate goal of the project, which is to present structural and operational concept(s) and model(s) that secure or at least support the global competitiveness of Finnish manufacturing industry, companies and networks. The challenges identified and the recommendations presented in the paper also point out possible and potential directions for research and development that are relevant and important for manufacturing companies and their success.

REFERENCES

- Alsèn, A., I. Colotla, M. Daniels, B. Kristoffersen and P. Vanne (2013). *Revitalizing nordic manufacturing: Why decisive action is needed now*. Boston Consulting Group, Boston.
- Baden-Fuller, C., D. Targett and B. Hunt (2000). Outsourcing to outmanoeuvre. *European Management Journal*, Vol. 18, pp.285–295
- Bellgran, M. and K. Säfsten (2010). *Production Development: Design and Operation of Production Systems*. Springer, London.
- Bengtsson, L. (2008). Outsourcing manufacturing and its effect on engineering firm performance. *International Journal of Technology Management*, Vol. 44, pp. 373-390.
- Cammish R. and M. Keough (1991). A strategic role for purchasing. *The McKinsey Quarterly*, Vol. 3, pp. 22–39.
- Chen, I.J. and A. Paulraj (2004). Towards a theory of supply chain management: the constructs and measurements. *Journal of Operations Management*, Vol. 22, pp. 119-150.
- Dabhilkar, M., L. Bengtsson, R. von Haartman and P. Åhlström (2009). Supplier selection or collaboration? Determining factors of performance improvement when outsourcing manufacturing. *Journal of Purchasing and Supply Management*, Vol. 15, pp. 143-153.
- De Toni, A. and G. Nassimbeni (1999). Buyer-supplier operational practices, sourcing policies and plant performances: results of an empirical research. *International Journal of Production Research*, Vol. 37, pp. 597-619.
- Hirsjärvi, S. and H. Hurme (2001). *Tutkimushaastattelu. Teemahaastattelun teoria ja käytäntö*. Helsinki University Press, Helsinki.
- Jackson, B. (1985). *Winning and Keeping Industrial Customer*. Lexington Books, Lexington.
- Kakabadse, A. and N. Kakabadse (2005). Outsourcing: current and future trends. *Thunderbird International Business Review*, March–April, pp.183–204
- Koho, M. (2010). *Production System Assessment and Improvement: A Tool for Make-to-Order and Assemble-to-Order Companies*. Tampere University of Technology, Tampere.
- KPMG (2000). *Den Danske Logistikanalyse*, Report Edited by KPMG Consulting, 3rd Edition, pp. 1–39.
- Lonsdale, C. (1999). Effectively managing vertical supply relationships: a risk management model for outsourcing. *Supply Chain Management: An International Journal*, Vol. 4, pp.176–183
- McIvor, R. (2005). *The Outsourcing Process*. Cambridge University Press
- Meixell, M.J. and V.B. Gargeya (2005). Global supply chain design: A literature review and critique. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 41, pp. 531-550.
- Miltenburg, J. (2005) *Manufacturing Strategy: How to Formulate and Implement a Winning Plan*. 2nd ed. Productivity Press, Portland
- Momme, J. (2002). Framework for outsourcing manufacturing: strategic and operational implications. *Computers in Industry*, Vol. 49, pp. 59-75.
- Sociology Central. *Sociological Research Skills, Research Methods*. <http://www.sociology.org.uk/methfi.pdf>
- Slack, N. and M. Lewis (2002). *Operations strategy*. Prentice Hall, Harlow.
- Wheelwright, S.C. (1984). Manufacturing strategy: defining the missing link. *Strategic Management Journal*, Vol. 5, pp. 77-91.