Global Supply Chain Design
Exploring configurational and coordination factors

Licentiate thesis by
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Abstract

This thesis addresses the topic of global supply chain design. One major challenge concerns how to manage the tension between separation and integration pertaining to the localization of business activities. In this regard Ferdows (2008) worked to create two new production network models (*rooted production network* and *footloose production network*). Earlier studies have highlighted the choices that are involved in the network of facilities but lack in providing a comprehensive picture in terms of both configurational and coordination factors that govern the design of global supply chain. There is a need for a conceptual model where factors affecting the design process of a global supply chain can be applied. Two main research questions have been addressed in this study. First, exploring and identifying the factors affecting global supply chain design. Second, investigating the factors that influence the position on the spectrum of rooted and footloose supply chain design.

A literature review analysis and multi-case studies have been performed for this study in order to explore the factors. The companies were selected in order to reflect upon the two types of network, i.e., rooted and footloose. The primary data were selected through interviews with the managers.

This study highlighted that there are many factors that affect configurational and coordination decision areas within a global supply chain. This study categorized the factors and the configurational/coordination decision areas with two main competitive priorities, i.e., cost and differentiation in the form of a “conceptual model.” The study also highlighted the factors in a matrix, which showed their position on the spectrum of rooted and footloose network configurations. For instance, the coordination factors that drive towards a footloose network include: *high orchestration capabilities, need access to new technology and knowledge, proximity to suppliers*, etc. The configurational factors that drive towards a rooted network include: *economic stability, proximity to market, concerns for sustainability issues, high transportation cost, need for high proximity between key functions, need for intellectual property rights protection*, etc.
Acknowledgements

I would like to thank my supervisors, Professor Lars Bengtsson at the University of Gävle, Associate Professor Mandar Dabhilkar at Stockholm University School of Business, and Rolland Hallberg (former researcher) at the University of Gävle, for their guidance, support and constructive criticism on my work. Special thanks to Lars, for giving me an opportunity to explore myself in academia. Thanks to Andreas Feldmann, lecturer at KTH Royal Institute of Technology, for reviewing my thesis work. Also thanks to my colleagues, Kaisu, Stefan, Robin, Weihong, Ioana and Lars.
Table of Contents

1. Introduction ........................................................................................................... 1
   1.1. Background .................................................................................................... 1
       1.1.1. The research problem and the research gap ...................................... 1
   1.2. Purpose and research questions ..................................................................... 2
   1.3. Outline of the thesis ...................................................................................... 3

2. Methodology .......................................................................................................... 4
   2.1. Choice of scientific approach ......................................................................... 4
   2.2. The research strategy ..................................................................................... 5
   2.3. The research process ...................................................................................... 6
   2.4. The case companies ....................................................................................... 7
   2.5. Data collection techniques ............................................................................ 8
   2.6. Literature review ............................................................................................ 10
   2.7. Data analysis ................................................................................................ 10
   2.8. The quality of the research ........................................................................... 12
       2.8.1. Reliability and validity ........................................................................... 12
           2.8.1.1. Construct validity ......................................................................... 12
           2.8.1.2. Internal validity ........................................................................... 12
           2.8.1.3. External validity ......................................................................... 12
           2.8.1.4. Reliability .................................................................................... 12

3. Literature review ................................................................................................... 13
   3.1. Competitive priorities ................................................................................... 13
   3.2. Supply chain management ............................................................................ 13
   3.3. Supply chain configuration .......................................................................... 14
   3.4. Global supply chain design ......................................................................... 14
   3.5. Configurational and coordination decision areas within global supply chain
design ......................................................................................................................... 17
   3.6. Factors affecting global supply chain design .............................................. 18
   3.7. Competitive priorities and the factors within global supply chain
configuration ............................................................................................................. 19
   3.8. Factors influencing the position on the spectrum of rooted and footloose
supply chain configurations ................................................................................. 20
       3.8.1. Factors affecting shifts towards rooted configurations ..................... 20
3.8.2. Factors affecting shifts towards footloose configurations ............ 20

4. Summary of appended papers ................................................................. 21
   4.1. Paper 1: Factors affecting global supply chain design .................. 21
   4.2. Paper 2: Relationship between competitive priorities and global supply chain design: A conceptual framework .................................................. 21
   4.4. Summary of the cases ................................................................. 23
      4.4.1. Rooted and footloose networks, related findings .................. 23
      4.4.2. Factors drive towards footloose configuration .................. 27
      4.4.3. Factors drive towards rooted configuration .................. 30

5. Analysis and discussion ................................................................. 32
   5.1. RQ1(a) and RQ1(b): What are the factors affecting global supply chain design? ................................................................. 33
   5.2. RQ2: How do various factors influence the position on the spectrum of rooted and footloose supply chain design? ................................................................. 39

6. Conclusion ....................................................................................... 44

7. References ....................................................................................... 46

8. Appendix ....................................................................................... 52
   Appendix 1 Questionnaires
   Appendix 2 Paper 1
   Appendix 3 Paper 2
   Appendix 4 Paper 3
List of appended papers

Paper 1

Paper 2

Paper 3
1. Introduction

This chapter explains the background of the study and the research problem. This section highlights the key theoretical gaps in global supply chain design. The scope of the study is also discussed here, followed by the thesis outline.

1.1. Background

1.1.1. The research problem and the research gap

There are several examples of companies striving to balance integration and separation of their activities to achieve competitiveness. One phenomenon seen in the United States, Europe and Japan is the trend of going back to the origin. See, for instance, in the US (“Reshoring manufacturing”, 2013), in Sweden (Bengtsson, 2013; ADA Sweden, 2014); in the United Kingdom (Groom, 2013 & 2014b); and in Japan, (Thompson & Soble, 2014).

“If we get out of manufacturing, we will lose” Yun Jong Yong, CEO and vice chairman of Samsung Electronics, (Edwards et al., 2003).

However, a few examples illustrate a different trend, i.e., instead of going back home, the companies are looking for alternatives. See for instance, in the United Kingdom (Groom & Powley, 2014a) and in Japan (Soble, 2011).

“The ideal strategy for a global company would be to put every factory it owned on a barge and float it around the world, taking advantage of short-term changes in economics and exchange rates” Jack Welch, Chief Executive of GE (“The story so far,” 2013).

How supply chains should be designed to best meet this tension has been analyzed in supply chain literature for a long time. The above examples also show that in order to be competitive in the market, firms reconfigure value-creating strategies by focusing on competitive priorities. The re-configuration and management become critical due to trade-offs between objectives (Skinner, 1969). Dabhilkar (2011) studied the trade-offs in make-buy decisions and establishes the link between the competitive priorities and the motives for outsourcing; this study supports the trade-off model. In this regard, there are some examples as well, for instance, the trade-off relationship between price, speed and flexibility encourages the Arcadia group (a British multinational retailing company) to make a small percentage of its clothes in the United Kingdom (Felsted, 2014). The survey of the Manufacturers Organisation for UK Manufacturing (EEF) showed that about 35% of the respondents considered “quality” as the main reason to re-shore production back to the United Kingdom,
followed by “certainty,” deliverability” and “goal to reduce transportation costs” (Groom & Powley, 2014a).

There are certain network capabilities (namely, access to market or resources, efficiency, mobility and learning) that can be linked with competitive priorities (Mundt, 2012). In the literature, the relationship between manufacturing strategy and competitive priorities has been established, for instance, Swamidas and Newell (1987); Leong et al. (1990); Mills et al. (1995); Slack et al. (2010); Dangayach and Deshmukh (2001); Slack and Lewis, (2011). There is a gap in the literature, however, where global supply chain configurations could be linked with competitive priorities.

Besides that, it is also important to have broader understanding of supply chain network structure (Friedli, et al., 2014). They highlighted that the literature on global manufacturing can be divided into two dimensions: some consider it the organization of a firm within a network, and others emphasize inclusion of other areas, like suppliers in the manufacturing network. In the literature, manufacturing management has been studied at the site level, for instance by Rudberg and Olhager (2003). The importance of individual sites in a production network from the global perspective cannot be neglected (Canel and Khumawala, 2001; Ferdows, 1997; Vorlurka and Davis, 2004; and Vereecke et al., 2006; Shi, 2003; Shi and Gregory, 1998; and Rudberg and West, 2008). The decision areas of such systems can be divided into configuration and coordination (Friedli et al., 2014). Existing literature lacks in providing a comprehensive picture in terms of both configurational and coordination factors that govern the design of global supply chain.

Again, in the literature, earlier studies, e.g., Kouvelis & Su (2005), highlighted the choices that are involved in the network of facilities, which is the “overall plan for how the company will manufacture products on a worldwide basis to satisfy customer demand worldwide” (McGrath and Bequillard, 1989, p. 23). Ferdows (2008) worked further in this regard, proposing two new production network models (rooted production network and footloose production network). With examples, Ferdows explored a few dimensions regarding the shifts in the manufacturing networks. However, his study only focused on configurational aspects of a network design.

1.2. Purpose and research questions

Based on the above context, the purpose of the research is to explore and identify the factors affecting global supply chain design, which leads to the following research questions:
• RQ1(a): What are the factors affecting global supply chain design?
• RQ1(b): How do various factors that affect global supply chain design relate to competitive priorities?
• RQ2: How do various factors influence the position on the spectrum of rooted and footloose supply chain design?

1.3. Outline of the thesis

Chapter 1: This chapter explains the background of the study and the research problem, and highlights the key theoretical gaps in global supply chain design.
Chapter 2: This chapter explains the methodology, how the case companies were selected, and how the analysis was done.
Chapter 3: This chapter provides a literature review.
Chapter 4: This chapter gives a summary of the appended papers.
Chapter 5: This chapter discusses and analyzes the research questions, the findings and relates to previous research.
Chapter 6: This chapter highlights the contributions of the study
2. Methodology

2.1. Choice of scientific approach

Laudan (1982) stated that there are the following five fundamental properties that distinguish scientific knowledge from other things: “(i) it is guided by natural law, (ii) it has to be explanatory by reference to natural law, (iii) it is testable against the empirical world, (iv) its conclusions are tentative, i.e., are not necessarily the final word, and (v) it is falsifiable.” (p. 16). Mertens (2010) defines a paradigm as “a way of looking which is composed of certain philosophical assumptions that guide and direct thinking and action” (p. 7), and Guba & Lincolin (1994) defined paradigm as “the basic belief system or worldview that guides the investigator, not only in choices of methods but in ontologically and epistemologically fundamental ways” (p. 105).

The ontological question relates to the form and nature of reality, the epistemological question deals with the nature of the relationship between the researcher and what can be known and the methodological question is about the way to get the findings (Guba & Lincoln, 1994).

The design process of a global supply chain is based on several strategic decisions; these decisions are driven by several factors. It is a complex process due to the fact that various factors must be taken into consideration. The main question is how various factors affect the decision areas in designing a global supply chain. In order to explore this area, I have conducted a thorough literature review and interviewed the managers. Due to the nature of the analysis and the “objective” nature of the research question (Chalmers, 1999). I am interested in a “positivist paradigm,” which was developed by the French philosopher Auguste Comte, who distinguished between natural philosophy and science. Positivism is based on the following three principles: (i) principle of verification, (ii) principle of observation, and (iii) principle of causality. The British philosopher Karl Popper (1902-1994) added the fourth principle of positivism, i.e., the principle of falsification. The ontological basis of positivism is realism and objectivism is the epistemological basis of this paradigm.

This study is based on qualitative research, and when it comes to methodology, some scholars have shown that qualitative research can be positivist, for instance, according to Yin (2009) case study research can be considered positivist; Walsham (1993) considers case studies as interpretive. Similarly, Clark (1972) and Elde & Chisholm (1993) argued that action research can be considered positivist and
interpretive respectively. The study by Orlikowski & Baroudi (1991) showed that positivists intend to test the theory in order to understand the phenomenon. It is possible to validate but requires more effort to understand the problem in positivism.

2.2. The research strategy

Yin (2009) stated that the method of data collection and analysis refers to a research strategy. He further stated that “a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when boundaries between phenomenon and context are not clearly evident” (p. 13). Eisenhardt (1989) also stated that the goal of a case study is to understand definite dynamics and associations with a single setting. The research questions “how” and “why” can be answered by the case study approach (Yin, 2009). For example, in this study there was an attempt to find out that how various factors affect the design of global supply chains. There are certain situations where the single case study is appropriate such as: (i) when the purpose is to test theories; (ii) specific conditions; (iii) longitudinal goals; and (iv) need for in-depth knowledge in complicated structures (Yin, 2009; Dubois & Gadde, 2002). Voss et al. (2002) reviewed case study research’s application in operations management in order to highlight suggestions for case-based research. These suggestions are sequential, however, they can be performed in parallel and repetitively. They highlighted that there are certain challenges in this type of research: (i) it is time-consuming; (ii) interviewer’s competence; (iii) more concerned with the way of drawing conclusion, and (iv) requires rigorous research. They addressed the following seven issues: “(i) when to use case research, (ii) developing the research framework, constructs and questions, (iii) choosing case, (vi) developing research instruments and protocols, (v) conducting the field research, (vi) data documentation, (vi) data analysis, hypothesis development and testing” (p. 196-7).

For this study, the abovementioned steps were followed as suggested by Voss et al. (2002) and multiple case studies were conducted, which facilities the researchers to investigate the diversity among the cases for the purpose of making comparisons (Yin, 2009; Dubois & Gadde, 2002). Miles & Huberman (1994) stated that “multiple-case sampling adds confidence to findings” (p. 29). Case studies can be classified into the following: exploratory, descriptive, illustrative and explanatory (Yin, 2009). Exploratory case study deals with the collection of data and field work in order to develop research questions and methods. In order to develop more than one
dimension and do logical and intense study, a descriptive study is appropriate. Illustrative case study dealing with a single case helps in illustrating specific phenomena (Yin, 2009). Hartley (2004) stated that “the explanatory case study should be an accurate and complete rendition of the features and ‘facts’ of the case, there should be some consideration of the possible alternative explanations of these, and a conclusion drawn based on the explanation which appears most congruent with the facts” (p. 330).

Study 1 (Paper 1) is about factors affecting global supply chain design and was performed with the help of five case companies. Study 2 (Paper 3) is about the factors affecting the position on the spectrum of rooted and footloose supply chain configurations and was performed with the help of two case companies. Study 3 (Paper 2) is about the relationship between competitive priorities and the factors affecting global supply chain design and was performed with the help of two case companies. In the case of supply chain design, management and control, which also constitutes the relations among the elements, could be analyzed holistically by viewing via a configurational approach (Neher, 2005). Table 1 highlights the case studies characteristics.

<table>
<thead>
<tr>
<th>Study</th>
<th>Exploratory</th>
<th>Explanatory</th>
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<tbody>
<tr>
<td>1</td>
<td>X</td>
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<td>2</td>
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<td>X</td>
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<tr>
<td>3</td>
<td>X</td>
<td>X</td>
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### 2.3. The research process

Crotty (1998) stated some suggestions regarding the research process and highlighted the following four questions that must be considered prior to a research proposal: (i) whether the research process is informed by certain epistemological conditions; (ii) in the research question, which theoretical philosophy supports the methodology; (iii) which methodology and application of the methodology governs the research; and (iv) selection of techniques and procedure. According to Dubois & Gadde (2002), a research study can increase the understanding between the theory and the empirical facts by an iterative process among different research activities. It could result in developing a new point of view (Kovács & Spens, 2005).
This research project started in March 2011. The project aims to deepen the understanding of supply chain strategies and their effects, with particular focus on how different factors affect the design of global supply chains that are both distributed and collocated. A key issue is the production-related skills and functions that can be separated and which ones need to be integrated/collocated to create efficient supply chains. The research process started with the pre-study in order to explore and develop understanding of the research questions (Voss et al., 2002). The pre-study also helped in identifying the case companies. In parallel with this activity, a literature review was written. The literature review helped to deepen the understanding of the area of global supply chain design, more specifically in finding the factors affecting the design process. The pre-study and literature review resulted in Study 1. A multi-case study was conducted for this study, and presented at a conference in 2012. Figure 1 below summarizes the research process for this study.

Based on the feedback received from the proceedings of the conference, Study 2 was conducted in two case companies. The results of Study 2 were presented at another conference in 2013. The study helped to categorize the identified factors. Study 3 was based on two case companies and a literature review. The results of Study 3 have been written in the form of a working paper.

2.4. The case companies

For all the studies, six companies were selected in order to reflect upon the two types of Ferdows (2008) models. All the case companies have global footprints and utilize both rooted and footloose network configurations.
2.5. Data collection techniques

Eisenhardt (1989) mentioned that documents, interviews, questionnaires and observations are the techniques which could be used in case studies. Yin (2009) highlighted six sources of evidence: documentation, archival records, interviews, direct observations, participant observation and physical artifacts.

The issues that were discussed with the selected companies covered the following areas: (i) the design process; (ii) supplier roles and global sourcing, which includes capabilities and salient characteristics of a supplier’s location in terms of infrastructure, human capital, culture, policies and regulations, etc.; (iii) challenges, such as: trust among different stakeholders, sustainability, substantial geographical distances, longer lead times, uncertainty, information confidentiality, measures to reduce cost, etc.; (iv) technological advancement; (v) communication and information flow mechanism; (vi) other issues related to management control such as complexities and management of functional process. In all three studies, semi-structured interviews were conducted and archival documents were used. The interviews were recorded and transcribed later. The conversation was done in English in order to minimize interpretation errors or thoughts in two different languages. The case companies were visited several times and follow-up interviews were made by telephone. In this context Voss et al. (2002) argued the same, i.e., where clarity of information is needed, it is important to revisit. From July 2011 to September 2011, empirical data were collected from five selected companies. The schedule was made based on the availability and convenience of the managers. The following Table 2 shows the summary. Follow-up interviews were conducted in January 2012 and February 2012. As the global supply chain design consists of both configurational and coordination decision areas, it is important to know that the managers that were interviewed held different positions in the respective companies. Due to their cross-functional experiences, it was easy to ask questions pertaining to different decision areas. For instance, in the case of company D, the interviewee has been employed since 1988, working in the supply chain area more or less all the time. As of October 2011 he was responsible for seven factories in Northern Europe and four factories in Sweden. Similarly, in the case of company E, the interviews were conducted with two persons at the same time, one was logistics and planning manager while the other was purchasing manager. Both joined the company in the mid-1970s. Previously, the
logistics manager worked as a transport purchase and planning manager, where he was responsible for the linkages between production and sales.

Table 2: Summary of the data collection technique

<table>
<thead>
<tr>
<th>Company</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visits frequency</td>
<td>Two</td>
<td>-</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>Interviews frequency</td>
<td>Two</td>
<td>-</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
<td>Two</td>
</tr>
<tr>
<td>Designation of the interviewees</td>
<td>Sourcing Manager</td>
<td>-</td>
<td>Vice President Purchasing/ Senior Manager</td>
<td>Director Order to delivery/ Senior Manager</td>
<td>Manager Logistics and planning</td>
<td>Purchasing Manager</td>
</tr>
<tr>
<td>Archival documents</td>
<td>Annual reports</td>
<td>-</td>
<td>Annual reports</td>
<td>Annual reports</td>
<td>Annual reports</td>
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<tr>
<td></td>
<td>Company Presentation slides</td>
<td>-</td>
<td>Company Presentation slides</td>
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<tr>
<th>P3</th>
<th>Visits frequency</th>
<th>Three</th>
<th>Four</th>
<th>-</th>
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</tr>
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<tbody>
<tr>
<td>Interviews frequency</td>
<td>Three</td>
<td>Four</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Designation of the interviewees</td>
<td>Business Development Manager</td>
<td>Sourcing Manager</td>
<td>Purchasing Manager/ Senior Manager</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Archival documents</td>
<td>Annual reports</td>
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<td></td>
<td>Company Presentation slides</td>
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</table>
For Study 2, two companies (C and D from Table 2) were short listed from Study 1 in order to reflect upon rooted and footloose network configurations. The companies were visited again in June 2012 and follow-up interviews were made by phone.

For Study 3, two companies (A and B from Table 2) were selected again, based on rooted and footloose network configurations. The companies were visited from April 2013 to July 2013. The interviews were conducted with business development manager, sourcing manager, purchasing manager and human resource manager. Table 2 above shows the summary. Follow-up interviews were conducted in September 2013 and February 2014.

2.6 Literature review

There are many suggestions for how to do a literature review as mentioned by, for instance, Bryman & Burgess (1999) and Croom (2009). Fink (2014) defined a research literature review as “a systematic, explicit and reproducible method for identifying, evaluating and synthesizing the existing body of completed and recorded work produced by researchers, scholars and practitioners” (p. 3). He divided the review process into seven tasks: (i) selecting research questions; (ii) selecting bibliographic or article databases, websites and other sources; (iii) choosing search terms; (iv) applying practical screening criteria; (v) applying methodological screening criteria; (vi) doing the review; and (vii) synthesizing the results. Besides case studies, this study is also based on the data from an extensive literature review. The literature review is based on the Pittaway et al. (2004) strategy, which suggests several stages. By following those stages, the following keywords were identified: global sourcing, global supply chain design, factors in a global supply chain design, multinational firms and global firms. These keywords were searched in several scientific databases, such as Emerald, Scopus, Google Scholar and Science Direct, and resulted in 550 articles. The sources were reviewed, according to the “inclusion” and “exclusion” criteria. The articles that do not deal with “global” and “supply chain” perspectives were excluded. The inclusion criteria were based on the factors affecting the decision-making in the design of a global supply chain, i.e., the elements or causes that dynamically influence the decision-making process.

2.7 Data analysis

Case study analysis is considered to be the least developed phase of performing a case study (Yin, 2009). There are five analytic techniques that can be applied in case study analysis: “(i) pattern matching, (ii) nonequivalent dependent variables as a
pattern, (iii) rival explanations as patterns, (iv) simpler patterns and (v) precision of pattern matching” (Yin, 2009, pp. 136-40). NVivo was used for a literature review, resulting in getting required information in a single node, which saved time and helped in the analysis. In this thesis recommendations by Miles et al. (2014) were followed for the analysis. According to Miles et al. (2014), there are three components of data analysis: (i) data reduction; (ii) data display; and (iii) conclusions, i.e., verification. They also suggested a checklist regarding storing, retrieving and retaining the data. The checklist may include raw material (field notes, site documents), coded data, search and retrieval records, data displays, etc.

In this study, at data reduction phase (Miles et al., 2014) of the literature review and case studies, the concept of rooted and footloose were deeply studied. According to the literature review, a global supply chain design includes two main categories of decision areas, i.e., configuration and coordination. The selection of identified factors was based on the context of configuration and coordination decision areas of a global supply chain. This stage is also called “data documentation and coding” as suggested by Voss et al. (2002).

According to Voss et al. (2002), the analysis stage is made up of two components, as mentioned by Miles et al. (2014), i.e., data display (presenting information analytically, e.g. matrices) and drawing conclusions. At these phases, the identified factors were reviewed in order to find the answers to the research questions. The concept matrix (based on the literature review) and the common factor matrices (based on case companies) helped to see the patterns, compare, identify new relationships, integrate the displayed data and develop explanations, and this process went on iteratively between the analytic text and the display. The following set of “tactics” were followed as suggested by Miles et al. (2014) in order to produce meaning: (i) Noting patterns and themes; (ii) seeing plausibility; (iii) clustering by conceptual grouping (for instance, the identified factors are grouped with respect to cost and differentiation); (iv) making metaphors; (v) counting; (vi) making contrast and comparison (with the “concept matrix” of the factors affecting a global supply chain design” as also suggested by Salipante et al. (1982)); (vii) partitioning variables; (viii) subsuming particulars into the general, shuttling back and forth between first level data and making general categories; (ix) factoring; (x) noting relationship between variables; (xi) finding interesting variables; (xii) building a logical chain of evidence (highlighting common factors among the case companies); and (xiii) making
conceptual/theoretical coherence (here the conceptual model and a matrix are developed).

In order to verify the data, the case companies were visited multiple times and follow-up interviews were made by telephone. In this context Voss et al. (2002) argued the same, i.e., where clarity of information is needed, it is important to revisit.

2.8 The quality of research

2.8.1 Reliability and validity

2.8.1.1 Construct validity

During a study, the development of right indicators and measures for the phenomenon is called construct validity. Therefore, the use of multiple data sources, chain of evidence and the involvement of key actors in the process, plays a vital role (Yin, 2009; Voss et al., 2002; Bryman, 1989). In this study, interviews were recorded and transcribed later, which increases the validity of the results because it decreases the risk of misinterpretation. The transcripts were sent back to the companies for further checking.

2.8.1.2 Internal validity

Internal validity deals with the explanatory case study (Yin, 2009). As the patterns in the multi-case studies meet the results, it helped to support the internal validity. As the literature was reviewed multiple times, it also helps in strengthen the internal validity (Miles et al., 2014).

2.8.1.3 External validity

The extent to which the results are generalized is referred to as external validity. Miles & Huberman (1994) and Yin (2009) argued that the repetition and shifting of the gathered data should be possible in other perspective. In this kind of study, replication logic in multiple case studies could be used (Yin, 2009).

2.8.1.4 Reliability

Miles & Huberman (1994) stated that reliability tells how consistent the results would be over the passage of time and with other researchers and methods. In other words, it shows whether the same results can be achieved again (Yin, 2009). This study was done recently and all the interviews are recorded and have been documented.
3 Literature review

3.1 Competitive Priorities

Competitive priorities link market requirements and manufacturing objectives (Hayes and Wheelwright, 1984; Leong et al., 1990; Dangayach and Deshmukh, 2001; Slack and Lewis, 2011; Greasley, 2006). The external and internal perspective of competitive priorities deals with “market point of view” and “resource point of view” respectively (Slack and Lewis, 2011). In the literature, two kinds of relationships between competitive priorities can be seen, namely, trade-off and cumulative. (For a detailed review, see Paper 2).

3.2 Supply chain management

Stuart (1997) argues that many scholars use supply chain management and purchasing as interchangeable terms. However, Lamming (1996) expressed a broader view by relating purchasing activities to vehicle assemblers and the activities pertaining to the components, which leads to supplier relationships (Storey, 2002; Giunipero & Brand, 1996). Davis (1993) provides a view in which the process and activities from sourcing and transportation to the customers are integrated. This relates to the description of supply chain management. The perspective view of supply chain management is expressed by Chandrashekar & Schary (1999) in these words: “facilitating efficient and effective flows of physical goods and information in a smooth manner by electronic means are considered as virtual in any chain and network.” Many authors have identified the trend from “competition” towards “cooperation,” i.e., collaborative model, supplier networks, buyers & suppliers relationship, see e.g. Carr (1999), Christopher (2004) and Balakrishan (2004).

Davis (1993) stresses the importance of the whole scope of supply chain management from suppliers to customers. Bechtel & Jayaram (1997) stated different definitions of supply chain management based on the following schools of thought: (i) chain awareness school; (ii) linkage school; (iii) information school; and (iv) integration school. The chain awareness school contains the functional areas where supply chain management consists of flow of material from suppliers to customers. The linkage school considers supply chain as the linking mechanism of the production and supply process from raw materials to end customers by moving through other activities like manufacturing, distribution, etc. The information school
considers all actors of the supply chain to be informed. The integration school deals with a distribution channel management.

### 3.3 Supply chain configuration

“A commonly occurring cluster of strategy, structure, process and context” is defined as configuration (Miller, 1986), and the perspective of supply chain network configuration has been reviewed in Srai and Gregory (2008).

The activities that are located in different places globally are known as configuration. Coordination mechanisms or the operation of those activities is known as coordination (Porter, 1986). Coordination helps in maximizing competitive advantage (Taggart, 1998; Oliff et al., 1989), (See Paper 3).

### 3.4 Global supply chain design

In 1997, Fisher presented a framework to understand the nature of products and the related supply chains. The framework highlights the matching between the following: (i) functional products and efficient supply chain and (ii) innovative products and responsive supply chain. An efficient supply chain focuses on low cost issues, and is suitable with stable demand. A responsive supply chain focuses on differentiation issues such as flexibility, and is suitable with demand uncertainty. Although the Fisher (1997) framework provides a clear distinction between two supply chains as a starting point of supply chain design, it does not address global structure of supply chain design.

A global supply chain design is defined as a structure which consists of configurational and coordination decision areas. These decision areas can further be divided into several categories, for instance: factory location, production allocation, distribution logistics, supplier selection, alliance relationships, interface along supply chain and human resource management. According to Harrison (2001) there are certain prerequisites for designing a global supply chain, for instance, uncertainty and several conflicting goals. Kouvelis & Su (2005) state that a global supply chain has the following structure: “(i) factories locations, (ii) allocation of production to the various factories, (iii) how to develop suppliers for the plant, (iv) how to manage the distribution of products, (v) how to organize the interfaces along the global supply chain.” (p. 5). They reviewed four conceptual frameworks pertaining to the design of global supply chains starting with production, where they mentioned Kouvelis and Munson’s framework (market/plant/network dispersion focus) and Ferdows’ (1997) six types of global factories. In the third framework, Vereecke et al. (2006) extend the
work of Ferdows (1997) in the way that they highlight intangible properties of plants based on the knowledge flows between the plants. In the fourth framework, Cohen and Lee (1989) analyze the decisions in terms of resource deployment. Figure 2 illustrates that global supply chain connects the international borders, where different suppliers can coordinate and produce goods for the customers.

**Figure 2 Illustration of a global supply chain (Vidal and Goetschalckx, 1997)**

*Global supply network configuration*

Supply networks are also referred to as production networks in the literature (Nassimbeni, 2004), which are vertically integrated networks of supply units (Srai and Gregory, 2008). Global production is referred to as a process of transforming business activities from a local market to the networks of business (Shi and Gregory, 1998). Ferdows (2008) developed a model (as shown in Figure 3) containing two production network models, i.e., rooted and footloose production network. The example of Intel, the manufacturer of semi-conductor chips, as a case study, suggests the rooted manufacturing network configuration. On the other hand, the example of IKEA, Swedish furniture manufacturer, as a case study, suggests a footloose manufacturing network configuration (see Paper 3 for detailed description). In the rooted network model, a company establishes deep roots, for instance, in terms of commitment to allocate resources. This kind of model is helpful to leverage unique manufacturing capabilities in order to deal with an uncertain and volatile market. These capabilities can act as a competitive weapon. The main driving force behind a rooted network is the availability of capital investments, which helps in developing new knowledge and
training to sustain it. In a footloose network model, a company searches for better alternatives either inside or outside of the company. This kind of model is helpful with demand uncertainty and market volatility. A company takes advantage of others' capabilities and shifts focus towards other business operations, for instance, marketing. The positioning of companies between these two models could be different in the same industry (Ferdows, 2008). As shown in Figure 3, a footloose network is appropriate when a product starts becoming a commodity and shifts from proprietary production process to standard production process. Similarly, a company that manufactures a unique product with a unique production process cannot simply decide to shift towards footloose. There are several factors that contribute to these shifts in positioning. Ferdows (2008) highlights several drivers for rooted and footloose networks. These drivers are related to configurational aspects of global networks. However, coordination factors/drivers are not present in the model, which is a limitation.

![Figure 3 Production network model (Ferdows, 2008)](image-url)
**Offshoring and related concepts**

The term offshoring is opposite to re-shoring, when companies tend to take advantage more specifically of labor costs by either captive offshoring or outsourcing abroad. Gray et al. (2013) defined reshoring as “fundamentally concerned with *where* manufacturing activities are to be performed, independent of *who* is performing the manufacturing activities in question – a location decision only as opposed to a decision regarding location and ownership” (p. 28). Backshoring, homeshoring and reshoring are interchangeable terms for the same concept. However, nearshoring is referred to as the relocation of manufacturing activities near, but not in, the home country (Ellram et al., 2013).

In the above context, it can be stated that the concept pertaining to rooted and footloose networks are altogether different than terms like offshoring, reshoring, etc. These terms are specifically related to the location decisions, which do not fully illustrate other parameters of a global supply chain. On the other hand, with the help of rooted and footloose networks, a company's production and supply chain network can be illustrated in terms of both configuration and coordination.

**3.5 Configurational and coordination decision areas within global supply chain design**

At site level, decision categories of a production system have been studied in the literature, for instance, Hayes & Wheelwright (1984), Skinner (1996), Hill (2000), Slack & Lewis (2011) and Hayes et al. (2005), and these decision categories are divided into structural and infrastructure dimensions. Numerous authors have mentioned that configuration and coordination are two main decision categories at network level (e.g. Porter, 1986; Shi & Gregory, 1998; Colotla et al., 2003; Rudberg & Olhager, 2003). The literature suggests that configuration and coordination can further be distinguished into several decision areas, for instance, factory locations, production allocation, distribution logistics, supplier selection and alliance relationships (see Bolisani and Scarso, 1996; Buckley, 2009; Chopra and Meindl, 2010; Cohen and Mallik, 1997; Kouvelis and Su, 2005). Similarly, coordination decisions can be further distinguished into two areas: interface along supply chain and human resource management (see Meijboom and Vos, 1997; Kouvelis and Su, 2005; Chopra and Meindl, 2010). Table 3 shows the summary and details can be found in Paper 2.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Decision Areas in GSCD context</th>
<th>Sources (few examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Configurational decisions</td>
<td>Bolisani &amp; Scarso (1996); Buckley (2009); Chopra &amp; Meindl (2010); Cohen &amp; Mallik (1997); Harrison (2001); Kogut (1984); Kogut (1985); Kouvelis &amp; Su (2005); Meixell and Gargeya (2005)</td>
</tr>
<tr>
<td></td>
<td>For instance, Location of factories</td>
<td>Bolisani &amp; Scarso (1996); Buckley (2009); Kouvelis &amp; Su (2005); Martel et al. (2005); Prasad &amp; Sounderpandian (2003); Vidal &amp; Goetschalckx (1997)</td>
</tr>
<tr>
<td></td>
<td>Allocation of production logistics (Transportation &amp; Warehousing)</td>
<td>Arntzen et al. (1995); Kouvelis &amp; Su (2005); Chopra &amp; Meindl (2010); Cohen &amp; Mallik (1997); Creazza et al. (2010); Goh &amp; Ling (2003); Martel et al. (2005); Prasad &amp; Sounderpandian (2003);</td>
</tr>
<tr>
<td></td>
<td>Global sourcing / Supplier development</td>
<td>Alguire et al. (1994); Allon &amp; Mieghem (2010); Birou &amp; Fawcett (1993); Bozarth et al. (1998); Chan and Chan (2008); Haugland (1998); Kotabe &amp; Murray (2004); Kouvelis &amp; Su (2005); Meixell and Gargeya (2005); Platts &amp; Song (2010)</td>
</tr>
<tr>
<td></td>
<td>Alliance relationship</td>
<td>Andersen (1999); Aquilon (1997); Aulakh et al. (1996); Bachmann (1999); Dyer &amp; Chu (2002); Gehani (2000); Handfield &amp; Nichols (2004); Kelly et al. (2002); Kwon &amp; Suh (2004); Lane &amp; Bachmann (1996); Parkhe (1998a); Parkhe (1998b); Sako and Helper (1998)</td>
</tr>
<tr>
<td>2</td>
<td>Coordination decisions</td>
<td>MeiJboom &amp; Vos, (1997); Kouvelis &amp; Su (2005); Chopra &amp; Meindl (2010); Cohen &amp; Mallik (1997); Lambert &amp; Cooper (2000); Meixell and Gargeya (2005); Narain (2003)</td>
</tr>
<tr>
<td></td>
<td>For instance, Enterprise information infrastructure/inter faces along SC</td>
<td>MeiJboom &amp; Vos, (1997); Giunipero et al. (2006); Harvey &amp; Richey (2001); Hong et al. (2006); Okada (2004)</td>
</tr>
<tr>
<td></td>
<td>Human resource development (managers’ skills)</td>
<td></td>
</tr>
</tbody>
</table>

### 3.6 Factors affecting global supply chain design

An element or a cause that dynamically influences the design of a supply chain is referred to as a factor in this thesis which could influence the decision-making in designing a global supply chain. The relevant literature was reviewed and the identified factors were highlighted, as shown in section 5.1, Table 7. Bhatnagar and Sohal (2005) highlighted qualitative and quantitative factors in site location decision. The following factors are highlighted in their study: infrastructure, difference in cost level, technological competence, proximity to market, and stability (political and economic). The survey conducted in the study by Birou and Fawcett (1993) highlighted several factors, including: cost level difference, cultural difference, communication between geographical region, information sharing, technological competence, political and economic stability and delivery reliability.

Chan and Chan (2008) highlighted several factors as a result of case studies and survey analysis and mentioned “communication cooperation between geographic region and information sharing” as a factor. The case studies of Platts and Songs
(2010) in the United Kingdom also resulted in highlighting cultural and language differences as a factor. Vidal and Goetschalckx (1997) reviewed the literature pertaining to strategic production-distribution models. The article highlighted the important properties of the models. According to their studies, two main international issues are considered in global supply chain models and these are cost level difference and endowment factors.

Prasad and Sounderpandian (2003) studied the implications for information systems in global supply chain efficiency. They highlighted the factors in the following areas: procurement, processing and distribution. A number of factors are highlighted, for instance, endowment factors, which include: cost level difference in terms of labor cost, raw materials, etc., cultural factors and infrastructure.

Okada (2004) studied the Indian automobile industry to investigate the skill development for the workers. His study of 50 suppliers of two OEMs revealed that industrial transformations influence local suppliers in terms of skills and technical competence. Meixell and Gargeya (2005) reviewed the literature on global supply chain design. Their review is based on decision support systems. The main objective of their study was to understand the fit between theory and practical issues of designing a global supply chain. They categorized the selected models into four dimensions, i.e., decisions, performance, integration and globalization. While reviewing the model in terms of globalization considerations, they highlighted cost level difference as a noteworthy factor.

### 3.7 Competitive priorities and the factors within global supply chain configuration

A model is presented in the study of Friedli et al. (2014) having three layers: strategy, configuration and coordination. There are certain factors which support manufacturing strategy, such as quality, price, dependability, flexibility, service and innovation. Similarly, there are certain factors that support network strategy: markets and resource access, efficiency, learning and mobility (Shi and Gregory, 1998; and Miltenburg, 2009). The study by Colotla (2003) and Colotla et al. (2003) showed that competitive priorities affect the site as well as network level (see Paper 2 for detail). The other layers of the model (Friedli et al., 2014), i.e., configuration, contains four categories and coordination contains two categories. It is argued that the “fit” between the aforesaid parameters results in achieving the best performance.
3.8 Factors influencing the position on the spectrum of rooted and footloose supply chain configurations

3.8.1 Factors affecting shifts towards rooted configuration

Cost factor is highlighted in the studies by Narain (2003) and Bolisani and Scarso (1996). High technological competence is considered a factor in the United States by using regional knowledge (Almeida, 1996). Interpersonal relations can be strengthened by proximity in international supplier relationships (Andersen, 1999). Pertaining to international strategies the study by Bolisani and Scarso (1996) pointed out several factors, such as political and economic stability, etc. Macroeconomic factors, quality conformance issues, infrastructure and stability in political and economic terms have been discussed in Chopra and Meindl (2010) and Martel et al. (2005).

Similarly, the studies by Sako and Helper (1998), Kelly et al. (2002), Bhatnagar and Sohal (2005) and Buckley (2009) also show some factors. Porter and Rivkin (2012) show some factors leading to a shift towards rooted network configuration: proximity to the customers and market, access to skilled labor, infrastructure, etc. Ferdows (2008) also pointed out the following factors that drive towards a rooted production network: (i) focus on competence development/high technological competence; (ii) high quality conformance; and (iii) proximity to market/strategic growth area.

3.8.2 Factors affecting shifts towards footloose configuration

Ferdows (2008) pointed out the following factors that drive towards footloose production network: (i) cost level difference, more generous incentives from local authorities; (ii) faster changing technologies; (iii) more uncertainty about the future; and (iv) shorter product cycle. Several studies have been conducted in this regard, for instance, Birou & Fawcett (1993), Eberhardt et al. (2004) and Porter and Rivkin (2012).
4 Summary of appended papers

4.1 Paper 1: Factors affecting global supply chain design

The purpose of the paper is to explore the factors that affect global supply chain design. The paper is based on a literature review and a multi-case study. The selection of the companies was based on two dimensions, i.e., requirements on efficiency vs. responsiveness (Fisher, 1997). A literature review is based on the strategy in Pittway et al. (2004). The identified factors from the literature review are placed in the concept matrix (Salipante et al., 1982). We also categorize the identified factors from five case companies and the literature in five decision areas as suggested by Kouvelis and Su (2005) pertaining to the structure of global supply chains.

This paper is co-authored with Professor Lars Bengtsson, Roland Hellberg (research), and Associate Professor Mandar Dabhilkar.

4.2 Paper 2: Relationship between competitive priorities and global supply chain design: A conceptual model

The ambition of this paper is to provide a suggestion for a conceptual model in order to categorize how various factors that affect global supply chain design, the configurational and coordination decision areas with two main competitive priorities, i.e., cost and differentiation, relate to each other. The paper is based on two case companies. The selection of the companies is based on rooted and footloose configurations, as suggested by Ferdows (2008). The results show that while considering cost as the competitive priority, the following are important factors to be considered in configurational decision areas: cost level difference, incentive from local authorities and transportation cost. Regarding coordination decision areas, the results show that the following factors can be considered, while considering cost as the competitive priority: coordination, control and knowledge transfer costs. The results show that the following factors can be considered in configurational decision areas, while considering differentiation as the competitive priority: delivery reliability, flexibility and longer lead times, infrastructure, proximity to market and suppliers, quality conformance, stability, sustainability issues and technological competence. The results also show that the following factors can be considered in coordination decision areas, while considering differentiation as the competitive priority: communication and cultural factors, orchestration capabilities and proximity between key functions.
4.3 Paper 3: Factors affecting shifts in global supply chain networks: A configurational approach

This paper explores how various factors influence the position on the spectrum of rooted and footloose supply chain configurations (Ferdows, 2008). A literature review is presented to identify the factors that affect the shifts between the global supply chain network configurations. The paper is also based on two case companies. The selection of the companies is based on rooted and footloose configurations. The identified factors are differentiated in terms of configuration and coordination factors and merged in a matrix. The matrix consists of four quadrants. The first quadrant contains the following configurational factors that drive towards footloose network: faster changing technologies; high cost level difference (in terms of raw material, exchange rate, wages, taxes, and more generous incentives from local authorities); more uncertainty about the future; need for access to new technology and knowledge; need for delivery reliability; proximity to suppliers/other companies’ operations; and shorter product life cycle. The second quadrant contains the following configurational factors that drive towards rooted network: concerns about sustainability issues; flexibility and longer lead times; focus on competence development/need for high technological competence; low cost level difference (in terms of raw material, exchange rate, wages and taxes); need for good infrastructure in terms of telecommunication, transportation and energy; need for high quality competence; proximity to market/strategic growth area; and stability (economic/political). The third quadrant contains the following coordination factors that drive towards rooted network: focus on communication and cultural factors. The fourth quadrant contains the following coordination factor that drives towards footloose network: high orchestration capabilities.

This paper is co-authored with Professor Lars Bengtsson and Associate Professor Mandar Dabhilkar.
4.4 Summary of the cases

Based on the multi-case studies, Table 4 and Table 5 below highlight the common factors which drive towards footloose and rooted configuration respectively.

4.4.1 Rooted and footloose networks, related findings

Table 4 highlights the main characteristics of the rooted and footloose networks within the case companies.

Table 4: Summary of the rooted and footloose networks within the case companies.

<table>
<thead>
<tr>
<th>Company</th>
<th>Characteristics of Rooted network</th>
<th>Characteristics of Footloose network</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>• Main production facility in Sweden&lt;br&gt;• The company classifies its components in A, B and C. By following the manufacturing philosophy to design and manufacture in-house, “A” components are considered to be core components.&lt;br&gt;• The company has a wide range of local and global suppliers. For instance, for machine parts, the suppliers are localized due to factors such as: speed, deliverability and having lots of knowledge in production engineering and R&amp;D.&lt;br&gt;• In making prototype sections, local suppliers are more responsive and efficient.&lt;br&gt;• The company invests in industrial machinery to improve quality, productivity, cost reduction and increase capacity.&lt;br&gt;• The final product is normally shipped directly to the end user via a central distribution in Belgium.&lt;br&gt;• The company focuses on “smarter and more efficient transports” including optimization of the vehicle loading to reduce weight of the shipment and the space.&lt;br&gt;• The company encourages sourcing close to production sites for business reasons, and for the environmental and social benefits.&lt;br&gt;• Regarding employees’ competence development, the company offers 45 hours of training per employee, 70% on-the-job training, 20% coaching, 10% classroom. It is a key to attract and keep skilled employees.</td>
<td>• For the management, one of the challenges in global sourcing is how to get the best cost.&lt;br&gt;• Currently has 50 customer centers, located in 170 countries.&lt;br&gt;• Due to wider customer base and manufacturing, sourcing creates substantial challenges.&lt;br&gt;• The company has created new customers, good stable economic conditions in Asia today.&lt;br&gt;• There are assembly plants in Hungary and China. The main reason to have two offshoring factories is cost minimization in terms of labor cost. The top management in these countries is Swedish.&lt;br&gt;• The management is flexible in terms of low-cost alternatives.&lt;br&gt;• Due to faster growth, one thing that is being emphasised is to calculate the existing capacity. There is a trade-off between buying a part or making capital investment in order to expand or rebuild. Therefore growth is also a major challenge which drives towards global sourcing.&lt;br&gt;• The main driver to outsource or to make decision to buy, is the value of the product, i.e., some products do give enough value to the company.&lt;br&gt;• When it comes to mass production, due to major competition, the company has been forced by its partners or suppliers to low-cost countries. For instance, in China many suppliers are being dealt globally, but on the other hand there is a risk of having different culture at global level. Therefore, it is much more convenient to have European partners or suppliers. Since the customer base is more and more Asian therefore flexibility in supply...</td>
</tr>
</tbody>
</table>
The company ensures that the suppliers are innovative and highly committed to deliver.

The company has established global network of sub-suppliers to prevent supplier dependency.

Geographical spreads of suppliers: Europe 56%, Asia/Australia 25%, North America 17%, and South America 2%.

By leveraging the suppliers' capabilities in non-core components, the development of innovative and sustainable new products is carried out.

At first step of product development, the company's starts by looking at what value the part has per kg, because the cost of transportation is getting higher. R&D and purchasing people sit together and discuss the requirements such as quantity, delivery, packaging, etc.

The R&D, marketing and design functions currently enjoy close cooperation throughout the product development process in all sectors, but with even greater focus on customers and sustainable innovations.

The company does not outsource R&D, they have R&D facility in-house. Supplier capabilities in terms of product knowledge are not necessary.

Consumer insight and market knowledge is enhanced by expanding cooperation between the marketing, R&D and design functions, enabling products to reach the market quicker and ensuring that these products are preferred by more consumers.

For standard components/articles, there are many suppliers but for critical components like electronic components, the company does not have dual sourcing policy. However, the company is aware of the suppliers’ capabilities, therefore, if desired, the suppliers can be switched by shifting the inspection tools/testing equipment to another.

The successful integration of the acquired appliance manufacturers in Egypt and Chile, combined with extensive product launches and accelerated measures to leverage the Group’s global strength and breadth, yielded profitable growth and higher market shares.

Dedicated employees with diverse backgrounds play a crucial role in

<table>
<thead>
<tr>
<th>B</th>
<th>Chain is very important.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>The company's global manufacturing platforms facilitate the spread of successful launches from one market to another, with adaptations to local preferences.</td>
</tr>
<tr>
<td></td>
<td>About 35% of production has been moved. 19 plants have been closed and nine new plants have been built.</td>
</tr>
<tr>
<td></td>
<td>A large share of the production has been moved from high-cost to low-cost areas.</td>
</tr>
<tr>
<td></td>
<td>When relocating, the company is dependent on the capacity of suppliers for cost-efficient delivery of components and semi-finished goods.</td>
</tr>
<tr>
<td></td>
<td>More than 60% of the household appliances are currently manufactured in low-cost areas (LCA), a move that has both strengthened the competitiveness and increased its proximity to strategic growth areas.</td>
</tr>
<tr>
<td></td>
<td>Production has been relocated primarily from Western Europe and the U.S. to existing or new units in such countries as Thailand, Hungary, Poland and Mexico.</td>
</tr>
<tr>
<td></td>
<td>Within a few years, more than 70% of manufacturing will take place in low-cost areas. The aim is to increase capacity utilization and optimize manufacturing throughout the world for the respective product categories.</td>
</tr>
<tr>
<td></td>
<td>The following activities are being done to leverage the global strength: introduction of shared systems and standards to reduce capital intensity, lower product costs by modularization, greater share of procurement from low-cost countries, faster and more efficient processes for product development through global, cross-border units for product development, design and marketing.</td>
</tr>
<tr>
<td></td>
<td>Currently, the company has 230 suppliers. 30% of suppliers are from low-</td>
</tr>
</tbody>
</table>
creating the innovative corporate culture necessary for the company to achieve its vision.

- In 2012, a new leadership model was implemented that clearly states that managers at the company have the responsibility to be both business and people leaders. The model's elements are the basis by which managers are evaluated and future leadership capabilities are grown.
- iJam, or Innovation Jam, a 72-hour online brainstorming session open to all employees across the globe, was arranged in October 2012. The ambition was to identify new ideas.

| C | Main R&D is situated in Gothenburg but other locations also have R&D, purchasing activities.  
- In Skövde certain manufacturing components are centralized which supply internally. The main site for engines is in Skövde and the main site for gear boxes is in Köping. The company also manufactures smaller types of engines in Lyon (France), makes all engines for the U.S. market in Hagerstown (USA) but the parts are supplied from Skövde.  
- Everything for South America is made in Curitiba (Brazil) but a few parts come from Skövde. At Ageo (Japan), the parts are made in Japan and India.  
- Marketing people develop a 10-year plan after analysing the manufacturing capacity at all the facilities, i.e., what market to be targeted, what products will be needed, etc. Then these demands are fit into existing factories which are situated all over the world. For the next 5 years, the company normally knows suppliers’ capacity and plans accordingly. The next step is to estimate the landed cost of each factory. After discussing with the suppliers and own logistics company as a transport partner, i.e., how to handle this in an optimal way. This results in a concrete plan at least for the coming 5 years.  
- The management is aware of third party suppliers, as it is a standard procedure in the automobile industry. Since breakdown in a truck during operations (at the customer’s end) could result in a huge loss due to the impact on service level which the customer is providing, it is necessary to make extra effort in order to ensure the quality standards. |
| D | The supply chain design issues and The footprint of business activities is in cost countries. |
strategic approach is taken care of from the head office in terms of platform, what the infrastructure looks like, what the technology direction would be, how the supply chain would be governed and controlled, etc. strategic and half-way tactic and execution is done at all the sites.

- The company introduces new product continuously with constant allocation and co-allocation of existing products. Most of the production is in-house but the raw materials are procured from external suppliers.
- In distribution center the vast majority of suppliers are internal.
- The confidentiality level is quite high due to the core competence of the products.
- Since the company has a dominant position in the world this implies that innovative suppliers are always encouraged.
- The company is addressing some challenges as well such as: demand uncertainty, forecasting at all levels, knowledge of customer’s needs, and sustainability issues. Social and economic aspects are in good shape however, environmental aspects have far to go in terms of electricity consumption, packaging material, etc.

- Swedish production plant is responsible to provide basic material to 15 plants all over the world (Asia, North America, South America and Europe). The North American & European plants are running over capacity, however in South America the plants are running under capacity therefore need procurement. Normally suppliers are not involved in new product development, since the chemical industry is more focused on process development, therefore technology plays a major role in reducing the cost and focus on the application of the final products, for example process improvement programs are initiated in order to use sodium chlorate in more efficient way in bleaching process on the customer side.
- In purchasing context, most of the raw materials come from regional area, i.e., Europe and Sweden.
- The group has focused to include sustainability in all aspects of the value chain such as: sourcing managers functioning in partnership with suppliers to manage business integrity issues and to help them to bring sustainable value to

- The production sites are all over the world such as South America, North America, Europe, & Asia.
- Most of their sales are stocked standard which means that they have a planning cycle, results in not doing everything in just-in-time.

- The supplier base is located globally for example, the fatty acids are supplied from Indonesia, Malaysia, North America, South America, and the rock salt is supplied from North and South Americans suppliers.
- 80% of the suppliers are external i.e. located outside the group.

- The supplier base is located globally for:

- 80% of the suppliers are external i.e. located outside the group.
their customers, manufacturing sites optimizing processes, getting better energy efficiency.

- Regarding logistics activities, the group has joined the clean shipping index to begin measuring, comparing, and placing targets on distribution lines.

- The company is situated in the southern part of Sweden. The company is part of a big group comprised of 15 multi-brand companies, which designs, manufactures and markets bathroom ceramics, bath, shower products and furniture.

- The 20 production sites are located in Europe, however the sales and marketing network operates at global level.

- In cases when internal companies within the group do not produce the part then decisions are made to have external supplier based on the following criteria: price, quality and addressing the environmental concerns.

- The suppliers are located in Sweden, Europe and Asia. Europe is the main supply base.

- China and Portugal are the main locations of the suppliers in Asia and Europe respectively.

### 4.4.2 Factors drive towards footloose configuration

*Table 5 Common factors matrix, factors drive towards footloose configuration*

<table>
<thead>
<tr>
<th>Common Factors Matrix</th>
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</thead>
<tbody>
<tr>
<td>Factors drive towards Footloose configuration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S.</th>
<th>Factors</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High cost level difference in terms of raw material, exchange rate, wages, and taxes</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Need access to new technology and knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Need for delivery reliability in terms of supplier's capability</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>High orchestration capabilities</td>
<td></td>
<td>*</td>
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</tr>
<tr>
<td>5</td>
<td>Proximity to suppliers / other companies' operations</td>
<td></td>
<td>*</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Low coordination, control and knowledge transfer costs</td>
<td></td>
<td></td>
<td>*</td>
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</tr>
</tbody>
</table>

At company A, the assembly is typically lean and flow oriented and the final product is normally shipped directly to the end user via a central distribution center, which is located in Belgium. The company's purchasing process is decentralized and managed in the divisions; however, local purchasing (non-core) is mostly carried out by individual companies. For machine parts, the suppliers are localized because of knowledge in the production engineering and R&D.
It was found at company B that about 35% of company production has been moved from high-cost to low-cost areas. Production has been relocated primarily from Western Europe and the United States to Thailand, Hungary, Poland and Mexico. Currently, B has 230 suppliers, 35% of which are from low-cost countries. More than 60% of the company’s products are currently manufactured in low-cost areas (LCA), a move that has both strengthened its competitiveness and increased its proximity to strategic growth areas. When relocating, the management also depends on the capacity of suppliers for cost-efficient delivery of components and semi-finished goods. The company considers that building trust with stakeholders and demonstrating that the company is a responsible societal partner is important to them. The company strives for high levels of transparency regarding its actions and impacts, and openness in its dealings with stakeholders. For standard components/articles, the company has many suppliers but for critical components like electronic components, they do not have a dual sourcing policy. However, the management is aware of the suppliers’ capabilities, therefore, if desired, the suppliers can be switched by shifting the inspection tools/testing equipment to another.

Most of the components at company C come from external suppliers. However, in Skövde certain manufacturing components are centralized and supplied internally. The company is gaining more and more suppliers in low-cost countries and also putting emphasis on innovative suppliers. The need for localization in certain Asian markets is being discussed within the group and it is a big challenge for the group, which would gain quite a lot by having more suppliers in Asia. For that reason it has increased purchasing activities and opened a purchasing office in Shanghai, China a few years ago and in India where 30 people work in purchasing. In many cases suppliers are involved in the new product development process. For instance, sometimes the company completely designs a product and puts it out to the suppliers in order to manufacture. Some products are purchased directly from the external sources, and the third scenario in new product development is when a supplier has a product (for instance turbo charger) which does not 100% fit the requirements and application, in which case the company and supplier work together to develop the product. Here the suppliers’ knowledge and innovation capabilities come into play. This is one of the selection criteria for new suppliers in early stages of new product development. Reducing costs is one of the purchaser’s responsibilities, which is a continuous process with all the suppliers. The company has internal targets to reduce
cost. When it comes to risk in demand fluctuation, every month the company issues a 12-month forecast by EDI or by other means to all the suppliers. The suppliers get the best estimates about what the company (OEM) would have in 12 months. It is complemented with regular business reviews with the suppliers which is a regular round of business communication.

The main site for engines is in Skövde and the main site for gear boxes is in Köping. The company also manufactures smaller types of engines in Lyon (France), makes all engines for the U.S. market in Hagerstown (USA) but the parts are supplied from Skövde. Everything for South America is made in Curitiba (Brazil) but a few parts come from Skövde. At Ageo (Japan), the parts are made for Japan and India. The company works on a 10-year plan, based on the number of trucks, cars and busses the marketing people believes they would sell. Marketing people develop this 10-year plan after analyzing the manufacturing capacity at all the facilities, i.e., what market to be targeted, what products are needed, etc. Then they fit these demands in existing factories which are situated all over the world. For the next five years, the company normally knows suppliers’ capacity and plans accordingly. The next step is to estimate the landed cost of each factory. After discussing with the suppliers and logistics as a transport partner, i.e., how to handle this in an optimal way. This results in concrete plan for at least the next five years.

Pertaining to coordination factors, i.e., coordination costs, control costs and knowledge transfer costs, it is observed that at company D internal suppliers are fully integrated in the system to see the order generation and execution. However, the external suppliers are communicated through electronic integration. Similarly, at company E, every month a global meeting is conducted among all the stakeholders from Canada, USA, Japan, Europe and Thailand, etc. at 14:00 Swedish time.
4.4.3 Factors drive towards rooted configuration

Table 6 Common factors matrix, factors drive towards rooted configuration

<table>
<thead>
<tr>
<th>S#</th>
<th>Factors</th>
<th>Case</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low cost level difference in terms of raw material, exchange rate, wages, and taxes</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>2</td>
<td>High transportation cost / Substantial geographical distance</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Need for good infrastructure (in terms of telecommunication, transportation, energy)</td>
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<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Proximity to market / strategic growth areas</td>
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<td></td>
<td>*</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>Need for high quality conformance</td>
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<td>*</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Stability (political, economic)</td>
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<td></td>
<td>*</td>
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<tr>
<td>7</td>
<td>Concerns for sustainability issues</td>
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<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>8</td>
<td>Need for high technological competence</td>
<td></td>
<td></td>
<td></td>
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<td>*</td>
<td>*</td>
</tr>
<tr>
<td>9</td>
<td>Focus on communication and cultural factors</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Need for intellectual property rights protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Need for proximity between key functions (e.g., production and R&amp;D)</td>
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<td></td>
<td></td>
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<td>*</td>
<td></td>
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<tr>
<td>12</td>
<td>Flexibility and longer leadtimes</td>
<td></td>
<td></td>
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<td>*</td>
</tr>
</tbody>
</table>

At company A, the management considers the following motives for concentrated activities: cost level difference, resource availability in terms of infrastructure, proximity to strategic growth areas and high technological needs. The company has a wide range of local and global suppliers. For example for machine parts, the suppliers are localized due to considerable knowledge in the production engineering and R&D. In making prototype sections, local suppliers are more responsive and efficient. The company stresses that its business partners, such as suppliers, sub-contractors, and joint venture partners, must share the same standards for the environment, labor and human rights. The company also promotes local purchasing since it benefits the region, and supplier selection and evaluation is carried out on the basis of their commitment to social and environmental performance. The company continuously stresses the importance of lead time to the customers, since substantial geographical distance could result in longer lead time. They also focus on smarter and more efficient transports, including optimizing the vehicle loading to reduce the weight of the shipment and the space used and sending larger or combined deliveries to reduce the total emissions per transport.
At company B, the company has greater share of procurement from low-cost areas. They start by looking at what value the part has per kg, and highlight that the cost of transportation is getting higher. The company does not outsource R&D, they have R&D facility in-house. Supplier capabilities in terms of product knowledge are not necessary for them. The R&D, marketing and design functions currently enjoy close cooperation throughout the product development process in all sectors, but with even greater focus on customers and sustainable innovations.

At company C, the company classifies supply chain based on the components, whether strategic or not. The suppliers for strategic components by default become strategic suppliers. Currently the company has 40-80 strategic suppliers and they cover more than 90% of the value of an engine. The supplier should qualify on audits which company C does for the supplier. The selection criterion is based on their ability to supply quality products over a period of time, how advanced they are in quality management, their ethics, how they follow local legislation, etc. The company has a system called supplier evaluation model (SME); the people working in SEM visit suppliers all over the world. SEM people evaluate the country characteristics as well. Political and currency risk are also addressed while making decisions globally considering various variations in legislations which differ from country to country and influence supply chain design.

At company D, if necessary, suppliers are involved in the new product development process and the management is aware of their capabilities. The suppliers must be a leader in their field however; the confidentiality level is quite high due to the core competence of the products. Due to substantial distance (if lead time is long) the stocking policy overcomes this problem. For instance this happened due to the volcanic ash crisis which caused delays in flights in 2010. Technology and technical flexibility are also noteworthy factors which can help in shifting production from one place to another, i.e., in re-locating production.

At company E, the group has developed many sourcing programs which has resulted in cost control and security of supply. A global e-learning module has supplemented local employee safety programs and training. Process safety, product stewardship, raw material strategies and development of repeatable models to drive continuous improvement are aimed at further optimization. The group has focused on including sustainability in all aspects of the value chain, such as sourcing managers functioning in partnership with suppliers to manage business integrity issues and to
help them bring sustainable value to their customers, manufacturing sites optimizing processes, getting better energy efficiency. In the purchasing context, most of the raw materials come from the regional area, i.e., Europe and Sweden. Every month a global meeting is conducted among all the stakeholders from Canada, United States, Japan, Europe, Thailand, etc. at 14:00 Swedish time. The supplier base is located globally for example, the fatty acids are supplied from Indonesia, Malaysia, North America and South America, and the rock salt comes from North and South American suppliers. Normally suppliers are not involved in new product development, since the chemical industry is more focused on process development. For that reason technology plays a major role in reducing the cost and focus on the application of the final products, for example, process improvement programs is initiated in order to use sodium chlorate in more efficient way in the bleaching process on the customer side.

Quality, transportation, lead time, price, sustainability and trust among all stakeholders are some factors which are always considered in supply chain design at company F. Cost reduction measures are taken continuously and one way to do this is supplier selection according to sustainability issues.

5. Analysis and Discussion

In this study a factor is considered as a motive or a cause that dynamically influences the decision-making in designing a global supply chain. It is important to note that identified factors are selected based on the context of configurational and coordination dimensions of a global supply chain and also in the context of rooted and footloose networks.

Back in 1986, the concepts of configuration and coordination were introduced, i.e., the activities that are located in various places worldwide in a value chain and the interactions of these activities, are referred to as configuration and coordination respectively. In terms of configuration and coordination, there are several studies which highlight the specific role of a site and can be related to configuration aspects as it deals with the specific advantages and competencies of a site. However, coordination aspects of a network are highlighted in terms of knowledge exchange. This study also considers a configurational factor as a motive or a cause that dynamically influences activities that are located worldwide and usually difficult to alter, and a coordination factor as a motive or cause that dynamically influences the
activities that deal with the relationships or interactions among global operations or activities.

In this study, a literature review shows that numerous authors have highlighted the decision categories of a manufacturing system. At site level, the decision categories are divided into structural (physical design, such as capacity) and infrastructural (operations, such as human resource management, production planning and control, etc.). On the other hand, at network level, there are two categories: network configuration and network coordination.

5.1. RQ1(a) and RQ1(b): What are the factors affecting global supply chain design?

Pertaining to the first question, i.e., the factors affecting global supply chain design, a literature review on global supply chain issues is presented, starting with definition of the terms, followed by reviewing the relevant literature in order to explore and identify the factors that influence the design of a supply chain.

Table 7 shows a concept matrix which highlights the following ten factors: (i) cost level difference; (ii) different cultural background and language difference; (iii) infrastructure in terms of transportation, telecommunication and energy; (iv) communication, cooperation between geographic regions and information sharing; (v) technological competence; (vi) duty, customs regulations and export regulations; (vii) proximity to customers/market; (viii) stability (political and economic); (ix) coordination, control and knowledge transfer cost; and (x) delivery reliability. The factors are placed with respect to configuration and coordination decisions. In the literature review, the following configuration decision areas are highlighted: factory location, production allocation, distribution logistics, supplier selection/development and alliance relationships. Similarly, the literature suggests that coordination decision areas include the following: interface along supply chain and human resource management. As mentioned earlier, a literature review was conducted in NVivo software. Table 8 highlights the factors from the selected sources.
Table 7. Concept Matrix of the factors affecting global supply chain design

<table>
<thead>
<tr>
<th>Factors</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cost level difference in terms of raw material, currency exchange rates, wages and taxes</td>
<td>✔</td>
</tr>
<tr>
<td>2. Different cultural background and language difference</td>
<td>✔</td>
</tr>
<tr>
<td>3. Infrastructure in terms of transportation, telecom, energy</td>
<td>✔</td>
</tr>
<tr>
<td>4. Communication, cooperation between geographic regions &amp; information sharing</td>
<td>✔</td>
</tr>
<tr>
<td>5. Technological competence</td>
<td>✔</td>
</tr>
<tr>
<td>6. Duty, customs regulations &amp; export regulations</td>
<td>✔</td>
</tr>
<tr>
<td>7. Proximity to customers / market</td>
<td>✔</td>
</tr>
<tr>
<td>8. Stability (Political, economical)</td>
<td>✔</td>
</tr>
<tr>
<td>9. Coordination costs, Control costs, and Knowledge transfer costs</td>
<td>✔</td>
</tr>
<tr>
<td>10. Delivery reliability</td>
<td>✔</td>
</tr>
</tbody>
</table>

Table 8. Factors affecting global supply chain design (NVivo)

<table>
<thead>
<tr>
<th>Nodes</th>
<th>Sources</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost level difference in terms of raw material, currency exchange rates, wages and taxes</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Different cultural background and language difference</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Infrastructure in terms of transportation, telecom, energy</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Technological competence</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Communication, cooperation between geographic regions &amp; information sharing</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Duty, customs regulations &amp; export regulations</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Proximity to customers / market</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Stability (Political, economical)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Coordination costs, Control costs, and Knowledge transfer costs</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Delivery reliability</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

It is interesting to note that in the literature the most highlighted factor affecting global supply chain design is “cost level difference.” As shown in Table 8 above, “different cultural background and language difference” is the second dominating factor in the literature. In order to add and validate the identified factors, empirical data from six Swedish companies are collected; the selection of the companies is also based on rooted and footloose network configurations. Table 9 highlights the common factors found in the case companies.
Table 9. Common factors matrix affecting global supply chain design (all selected case companies)

<table>
<thead>
<tr>
<th>Common Factors Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factors</td>
</tr>
<tr>
<td>Cost level difference in terms of raw material, exchange rate, wages, and taxes</td>
</tr>
<tr>
<td>Access to new technology and knowledge</td>
</tr>
<tr>
<td>Delivery reliability in terms of supplier’s capability</td>
</tr>
<tr>
<td>Orchestration capabilities</td>
</tr>
<tr>
<td>Proximity to suppliers / other companies’ operations</td>
</tr>
<tr>
<td>Transportation cost / Substantial geographical distance</td>
</tr>
<tr>
<td>Good infrastructure (in terms of telecommunication, transportation, energy)</td>
</tr>
<tr>
<td>Proximity to market / strategic growth areas</td>
</tr>
<tr>
<td>High quality conformance</td>
</tr>
<tr>
<td>Sustainability issues</td>
</tr>
<tr>
<td>High technological competence</td>
</tr>
<tr>
<td>Focus on communication and cultural factors</td>
</tr>
<tr>
<td>Intellectual property rights protection</td>
</tr>
<tr>
<td>Proximity between key functions (e.g. production and R&amp;D)</td>
</tr>
<tr>
<td>Flexibility and longer leadtimes</td>
</tr>
<tr>
<td>Coordination costs, Control costs, and Knowledge transfer costs</td>
</tr>
</tbody>
</table>

As highlighted in Tables 5, 6 and 7 above there are certain factors which are found in both the literature and the case companies: (i) cost level difference (in terms of raw material, currency exchange rates, wages and taxes); (ii) delivery reliability in terms of supplier’s capability; (iii) good infrastructure (in terms of telecommunication, transportation and energy); (iv) proximity to market/strategic growth areas; (v) stability (political/economic); (vi) high technological competence; (vii) focus on communication and cultural factors; and (viii) coordination, control and knowledge transfer costs.

Similarly, there are certain factors which are discussed with the case companies but not found in the literature. These factors include: (i) access to new technology; (ii) orchestration capability; (iii) proximity to other companies’ operations; (iv) transportation cost/substantial geographical distance; (v) high quality conformance; (vi) sustainability issues; (vii) intellectual property rights protection; (viii) proximity to key functions; and (ix) flexibility and lead times.

Before discussing the conceptual model, it is important to briefly highlight again an important study in this context. Colotla (2003) and Colotla et al. (2003) have studied the linkages between the network competencies (as highlighted by Shi and
Gregory, 1998; Miltenburg, 2009; Friedli et al., 2014) and a manufacturing site. They also studied the effects of the network competencies on the competitive priorities and found that the competitive priorities affect both levels, i.e., site and network level.

The conceptual model (as shown in Table 10) consists of four main parts: (i) competitive priorities; (ii) configurational decision areas; (iii) coordination decision areas; and (iv) the factors affecting global supply chain design.

<table>
<thead>
<tr>
<th>Global Supply Chain Design</th>
<th>Conceptual Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive priorities</td>
<td>Factors affecting configurational decision areas (such as factory location, production allocation, distribution logistics etc.)</td>
</tr>
<tr>
<td>Cost</td>
<td>Cost level difference (in terms of raw material, exchange rate, wages, and taxes); Incentives from local authorities (in terms of duty, customs regulations and export regulations); Transportation cost / geographical distance.</td>
</tr>
<tr>
<td>Differentiation</td>
<td>Access to new technology and knowledge; Delivery reliability; Flexibility and longer lead times; Infrastructure (in terms of telecommunication, transportation, energy); Intellectual property rights; Proximity to market/strategic growth area and suppliers; Quality conformance; Stability (political, economic); Sustainability issues; Technological competence.</td>
</tr>
<tr>
<td>Dependability</td>
<td>(trustworthy &amp; reliable).</td>
</tr>
<tr>
<td>Flexibility</td>
<td>(product, volume, delivery) (willingness to change or compromise).</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>(advanced &amp; original).</td>
</tr>
<tr>
<td>Quality</td>
<td>(degree of excellence).</td>
</tr>
<tr>
<td>Speed</td>
<td>(rate of operations).</td>
</tr>
</tbody>
</table>
Based on the literature review, two main competitive priorities are selected: cost (amount to be paid, effort, loss or sacrifice), and differentiation, which includes, for instance, dependability (trustworthy and reliable), flexibility in terms of product, volume, delivery (willingness to change or compromise), innovativeness (advanced and original), quality (degree of excellence), and speed (rate of operations).

Several factors are related to the situation where companies focus on “cost” as their competitive priority and exploit others’ capabilities and are mostly source-focused. Regarding configurational decision areas the following factors are identified which need to be considered while considering “cost” as the competitive priority: (i) “Cost level difference (in terms of raw material, currency exchange rate, wages, taxes); (ii) Incentives from local authority (in terms of duty, customs regulations and export regulations); and (iii) Transportation cost (substantial geographic distance). As in the case of company B, it is found that the company starts product valuation by analyzing weight-to-cost ratio and decides to produce in-house considering high transportation cost” (Paper 2). The case companies consider low cost level difference as incentive to concentrate business operations and high cost level difference as incentive to disperse business operations. “Regarding coordination decision areas the following factors are identified which need to be considered when using “cost” as the competitive priority: (i) Coordination costs (ii) Control costs and (iii) Knowledge transfer costs” (Paper 2).

“Similarly, in configurational and coordination decision areas, several factors are also related to the situation where companies focus on “differentiation” as their competitive priority and are mostly operations-focused. For instance, in the case of configurational decisions, as dependability refers to trustworthiness and reliability, it is shown that (i) Delivery reliability, (ii) Infrastructure in terms of telecommunication, transportation, and energy, (iii) Stability (political and economic), and (iv) Sustainability issues, are the important factors. As in the case of company A, all shareholders share the same standards in terms of labor and environment and encourage local purchasing to benefit the region. In coordination decision areas, (i) Communication and cultural factors is considered to be an important factor” (Paper 2).

“As it is defined that willingness to change or compromise is flexibility, global manufacturing platforms facilitate the spread of successful launches from one market to another, with adaptations to local preferences. In this context, (i) Access to new technology and knowledge and (ii) High orchestration capabilities, need to be
considered while making configuration and coordination decisions respectively. For instance, in the case of company A, having a global footprint with purchasing operations decentralized and organized in the divisions” (Paper 2).

“It is observed that the companies ensure productive relationships with the suppliers as a primary aim, ensuring that suppliers are innovative and highly committed to deliver the right quantities at the right times. Technological competence is also important for the companies in order to keep building expertise, to be innovative and to ensure Quality conformance, while protecting Intellectual property rights” (Paper 2).

“In terms of location, while considering speed as a competitive priority, (i) Proximity to market and suppliers and (ii) Proximity to key functions, need to be considered while making configuration and coordination decisions respectively. For instance, in the case of company B, R&D facility is in-house, while other functions like marketing can cooperate in product development” (Paper 2).

The companies also continuously stressed the importance of lead time to the customers, because substantial geographical distance could result in Longer lead time. The companies’ focus is on smarter and more efficient transports, including optimization of vehicle loading to reduce the weight and space of the shipment, and send larger or combined deliveries to reduce the total emissions per transport. It is noted that local suppliers are more responsive and efficient.

The above results can be placed in contrast to Fisher's (1997) two types of supply chains, i.e., efficient supply chain and responsive supply chain. He made a clear distinction between functional and innovative products, based on the following aspects: demand, product life cycle, contribution margin, product variety and lead time to market-to-order products. Fisher (1997) also made a clear distinction between efficient and responsive supply chains, which is based on the following aspects: main purpose, manufacturing focus, inventory strategy, lead-time focus, approach to choosing suppliers and product-design strategy. One aspect worth mentioning is that in an efficient supply chain, suppliers are selected based on cost and quality. However, in a responsive supply chain, suppliers are selected based on speed, flexibility and quality. In the above context, it can be noted that the suggested conceptual model (see Table 10) is different than Fisher's (1997) model because Fisher's model does not take into account the global perspective, configurational and coordination dimensions.
5.2. RQ2: How do various factors influence the position on the spectrum of rooted and footloose supply chain design?

The second research question, i.e., how do various factors influence the position on the spectrum of rooted and footloose supply chain configurations, seeks to extend Ferdows’ (2008) production network models by adding the factors affecting shifts between rooted and footloose network configurations. Figure 4 shows a matrix of the factors affecting shifts between the network configurations.

![Figure 4 Factors affecting shifts between global network configurations](image)

The matrix consists of four quadrants. The first quadrant (I) represents the configurational factors that drive towards a footloose network. The second quadrant (II) represents the configurational factors that drive towards a rooted network. The third quadrant (III) represents the coordination factors that drive towards a rooted network. The fourth quadrant (IV) represents the coordination factors that drive towards a footloose network. Ferdows (2008) pointed out the following factors that drive towards footloose production networks: (i) cost level difference, more generous incentives from local authority; (ii) faster changing technologies; (iii) more uncertainty about the future; and (iv) shorter product cycle. This study illustrates the models of production network and identifies more factors (based on the literature...
review and the case companies), but also makes a distinction between configuration and coordination factors, as shown in Figure 4 above. In this context, the illustration of the case companies reveals the following factors:

(i) need access to new technology and knowledge (for instance, in the case of company C, in many cases suppliers are involved in the new product development process, while in some cases the company completely designs a product and puts it out to the suppliers to manufacture. Some products are directly purchased from external sources, and the third scenario in new product development is when a supplier has a product (for instance turbo charger) which does not 100% fit the requirements and application, in which case the company and supplier work together to develop the product. Here the suppliers’ knowledge and innovation capabilities come into account. This is one of the selection criteria for new suppliers in early stages of new product development.)

(ii) proximity to suppliers/other companies’ operations (for instance, in the case of company A, for machine parts, the suppliers are localized because of knowledge in the production engineering and R&D. Similarly, in the case of company B, for standard components/articles, the company has many suppliers but for critical components like electronic components, they do not have a dual sourcing policy. However, the management is aware of the suppliers’ capabilities, therefore, if desired, the suppliers can be switched by shifting the inspection tools/testing equipment to another.)

(iii) high orchestration capabilities (for instance, in the case of company D, the footprint of business activities is in more than 130 countries. There are three distribution centers, in Singapore, Holland and USA. The global supply chain system is totally transparent and connected. Roughly 50,000 order lines per day, they come mostly in afternoon local time and deliver next morning to most countries. Their biggest challenge is to have the highest possible quality in the shortest possible time. The quality level from their distribution center is below 50 ppm, i.e., in one million order lines they make less than 50 mistakes. If the orders are coming in before deadline, they ship more than 99.8% of the orders of the same line. It is a very good supply chain but still some things need to be improved and the management's responsibility also includes the transport and connection with the factories in different parts of the world through the distribution centers. The supply chain design issues and strategic approach are taken care of from the head office in terms of platform, what
the infrastructure looks like, what the technology direction would be, how the supply chain would be governed and controlled, etc. Strategic and halfway tactic and execution is done at all the sites. Similarly, in the case of company A, the company's purchasing process is decentralized and managed in the divisions, however, local purchasing (non-core) is mostly carried out by individual companies.

Ferdows (2008) also pointed out the following factors that drive towards rooted production network: (i) focus on competence development/high technological competence; (ii) high quality conformance and (iii) proximity to market/strategic growth areas. Again, this study adds more factors here and distinguishes between configuration and coordination factors (Figure 4). In addition to the factors common to other studies as mentioned in the literature review, the illustration of the case companies reveals the following factors in this context:

(i) Concerns for sustainability issues (for instance, in the case of company E, the group has developed many sourcing programs which resulted in cost control and security of supply. A global e-learning module has supplemented local employee safety programs and training. Process safety, product stewardship, raw material strategies and development of repeatable models to drive continuous improvement are aimed at further optimization. The group has focused on including sustainability in all aspects of the value chain such as: sourcing managers functioning in partnership with suppliers to manage business integrity issues and to help them to bring sustainable value to their customers, manufacturing site optimizing processes, and getting better energy efficiency. Similar, in the case of company F, cost reduction measures are taken continuously and one way to do that is supplier selection according to sustainability issues. Quality, transportation, lead time, price, sustainability and trust among all stakeholders are some factors which are always considered in supply chain design. In case of company A, the company stresses that its business partners such as suppliers, sub-contractors, and joint venture partners, must share the same standards for the environment, labor and human rights. The company also promotes local purchasing since it benefits the region, and supplier selection and evaluation is carried out on the basis of their commitment to social and environmental performance.)

(ii) Flexibility and longer lead times (for instance, in the case of company D, due to substantial distance (if lead time is long) the stocking policy overcomes this problem; this happened for instance due to the volcanic ash crisis which caused delay in flights in 2010). Technology and technical flexibility is also a noteworthy factor
which can help in shifting production from one place to another, i.e., in re-locating production. Similarly, in the case of company F, quality, transportation, lead time, price, sustainability, and trust among all stakeholders are factors that are always considered in supply chain design. In the case of company A, the company continuously stresses the importance of lead time to the customers, since substantial geographical distance could result in longer lead time. They also focus on smarter and more efficient transports, including optimizing vehicle loading to reduce the weight of the shipment and the space used and sending larger or combined deliveries to reduce the total emissions per transport.)

(iii) high transportation cost/substantial geographical distance (as in the case of company B, the company has greater share of procurement from low-cost areas. They starts by looking at what value the part has per kg, and highlighted that the cost of transportation is getting higher.)

(iv) need for high quality conformance (for instance, in case of company C, the company classifies supply chain based on the components, whether strategic or not. The suppliers for strategic components by default become strategic suppliers. Currently, the company has 40-80 strategic suppliers and they cover more than 90% of the value of an engine. The selection criterion is based on their ability to supply quality products over a period of time, how advanced they are in quality management, their ethics, how they follow local legislation, etc. The company has a system called supplier evaluation model (SME), where the people working in SEM visit suppliers all over the world. The SEM people evaluate the country characteristics as well. In the case of company B, the company has manufacturing philosophy to design and manufacture in-house those components that are critical for the performance of the equipment.)

(v) need for intellectual property rights protection (for instance in case of company E, normally suppliers are not involved in a new product development, since the chemical industry is more focused on process development, for which reason technology plays a major role in reducing the cost and focus on the application of the final products, for example process improvement programs is initiated in order to use sodium chlorate in a more efficient way in bleaching process on the customer side. Similarly, in the case of company D, if necessary, suppliers are involved in new product development process and the management is aware of their capabilities. The
suppliers must be a leader in their field however; the confidentiality level is quite high due to the core competence of the products.)

(vi) need for proximity between key functions (as in the case of company B, the company does not outsource R&D, they have R&D facility in-house. Supplier capabilities in terms of product knowledge are not necessary for them. The R&D, marketing and design functions currently enjoy close cooperation throughout the product development process in all sectors, but with even greater focus on customers and sustainable innovations.)

See Figure 4 for the distinctions between configuration and coordination factors. So far, it has been discussed here that the aforesaid factors show that the global network configurations are characterized as analyzing the global standardization and local tailoring. The selection of the right model primarily involves the hunt for competitiveness in terms of configuration and coordination. A firm faces difficult challenges in reconfiguring and coordinating the globally dispersed and concentrated activities, keeping in view those factors.
6. Conclusion

This study intends to contribute to global supply chain design and in particular to rooted and footloose supply chain networks. Two main research questions have been addressed in this study. First, what are the factors affecting global supply chain design? Second, how do various factors influence the position on the spectrum of rooted and footloose supply chain design?

Pertaining to the first research question and in comparison to previous research, which is mostly focused on configurational aspects of production networks, this study has contributed to extend both configurational and coordination dimensions of supply chain networks. For instance, the previous research highlighted the site advantages (such as “access to low cost production, proximity to market, use of local technological resources, control and amortization of technological assets, and pre-emption of competition” (Ferdows, 1989, p. 6; Ferdows, 2008). So, there are two main contributions related to the first research objective:

• This study highlighted the factors and their mutual effect on the configurational and coordination decision areas.

• This study categorizes the factors, the configurational and coordination decision areas with two main competitive priorities, i.e., cost and differentiation. While considering cost as the competitive priority, the following factors are important to consider: cost level difference (in terms of raw material, exchange rate, wages and taxes), incentives from local authorities (in terms of duty, customs and export regulations), transportation cost/substantial geographical distance, and coordination, control and knowledge transfer costs. While considering differentiation as the competitive priorities, the following factors are important to consider: access to new technology and knowledge, communication and cultural factors, delivery reliability, flexibility and longer lead times, infrastructure (in terms of telecommunication, transportation, energy), intellectual property rights, orchestration capabilities, proximity to market and suppliers, proximity between key functions, quality conformance, stability (political, economic), sustainability issues, and technological competence.

Pertaining to the second research question, the previous research (Ferdows, 2008) pointed out the following factors that drive towards footloose production network:
cost level difference, faster changing technologies, more generous incentives from local authorities, more uncertainty about the future, and shorter product life cycle. He also pointed out the following factors that drive towards rooted production network: focus on competence development/high technological competence and high quality conformance. So, there are two main contributions related to the second research question:

- Key factors were identified which drive towards rooted and footloose supply network configuration and distinguished between configuration and coordination factors.
- In addition to the factors common to other studies, the illustration of the case companies revealed the following factors: (i) concern for sustainability issues; (ii) flexibility and longer lead times; (iii) high transportation cost/substantial geographical distance; (iv) high orchestration capabilities; (v) need for access to new technology and knowledge; (vi) need for high quality conformance; (vii) need for intellectual property rights protection; (viii) need for proximity between key functions and (ix) proximity to suppliers/other companies’ operations.

For managers, the study suggests some insights into global supply chain networks. The identified factors, for instance, could help managers know when to invest and when to consider contract manufacturing.

In a nutshell, the following can be concluded pertaining to knowledge explored in this study: The link between competitive priorities and global supply chain design has been explored, showing how competitive priorities like cost and differentiation could be used as a starting point in the design process. Cost level difference is a significant factor in configurational decisions. However, in terms of differentiation, which is considered a broader term for different competitive priorities and due to uneven global growth patterns, it is essential to analyze the identified factors continuously.
7. References


8. Appendix

Appendix 1

Questionnaires

Questions regarding Global Supply Chain Design Strategies
Global manufacturing operations
(localization issues, production allocation and alliances)

1. In the last five years, did you shift from one location to another? If yes, what were the drivers / rationale? Which factors contributed in this regard?

2. Strategic reasons for site location?
   • Access to knowledge.
   • Access to low cost manufacturing.
   • Proximity to market.

3. How do you deal with substantial geographical distances which could result in longer lead time, forecasting problems, etc.?

4. How do you deal with uncertainty in the operations due to globalized environment?

5. How do you maintain confidentiality with regard to proprietary information?

6. What measures do you take in reducing costs, mitigating risks and driving continuous improvement in the value chain?

7. Do you consider that the extent of integrated and distributed knowledge results in efficient production strategies and localization?

8. To what extent does knowledge integration influence the choice of suppliers and their capabilities?

9. How do you handle complexities and manage the different functional process?

10. Could you give some examples in order to evaluate whether the management decisions were consistent with supply chain’s objectives and strategies?

11. Competitors:
   • How do you assess your competitors?
   • Companies rival in a related product /market and technologies?
   • Companies already pursuing your major market segment but with dissimilar products?

12. Strategic partnerships?

13. Mergers & acquisitions?

14. Marketing:
   • High volume, i.e., standardized versus low volume, i.e., high variety manufacture.
   • Customization, i.e., customer-driven or predetermined range by the manufacturer.
   • Product and geographical nichemanship, i.e., small groups of consumers with a particular common interest.
   • Integral versus modular product designs.
   • Product (design) and manufacturing lead times.
15. Current challenges?
16. Future outlook?

**Questions regarding Global Supply Chain Design Strategies**  
*Supplier Development / Selection*

1. **Drivers:**
   - What drives you to outsource the existing products? (for example: Cost reduction)
   - Did you want to focus the resources on the core business?
   - What are the other strategic goals which you considered while making the outsourcing decision?
2. Does outsourcing include changes of location and organizational change?
3. **The outsourcing process:**
   - What are the decision criteria before physical transfer?
     i. What is the needs and analysis process?
     ii. What are the criteria to choose a supplier and location?
     iii. The negotiation process?
   - Realization of decision phase:
     i. How do you evaluate your suppliers in decision phase?
   - Continuous supply from new source:
     i. How do you manage relationship between suppliers?
     ii. What is the hindrance you faced in case supplier’s contract terminated?
   - Why? (what are the drivers, *above mentioned already*)
   - What, (what is possible or profitable to outsource)
   - To whom (who is most suitable to take over the responsibility and become a supplier)
   - How? (How the structure and coordination between the outsourcing company and the supplier should be established and managed.)
4. **Sourcing country characteristics:**
   - Infrastructure:
     i. How important is the reliable communication infrastructure in outsourcing?
     ii. How important is lead time and delivery dependability in outsourcing?
   - Culture:
     i. Did you consider that language difficulties are barriers in outsourcing?
     ii. Did you consider that different understanding of tolerance & specification of products are barriers in innovation?
   - Human capital:
     i. How do you evaluate the importance of skilled labour in outsourcing country?
   - Policies & regulations:
i. How do you deal with legal systems, intellectual property rights protection, and interpretation of contracts?

5. How do you evaluate relationship between trust and management among different stakeholders in global supply chain relations? i.e., how do you evaluate the importance of trust in buyer-supplier relationships?

6. To what extent does knowledge integration influence the choice of suppliers and their capabilities?

7. Current challenges?

8. Future outlook?

Questions regarding Global Supply Chain Design Strategies

Distribution Logistics
(warehouse & transportation)

1. Warehouse locations? Size / capacity?
2. Logistics mechanism / ownership or 3PL?
3. In the last five years, did you shift from one location to another? If yes, what were the drivers / rationale?
4. What factors affect the decision regarding distribution of the various products in terms of transportation & warehousing? (in terms of local vs. global)
5. How do you deal with substantial geographical distances which could result in longer lead time, forecasting problems, etc.?
6. Do you consider sustainability as a challenge in the near future? And what are the strategies to deal with this?
7. How do you deal with uncertainty in the operations due to globalized environment?
8. What measures do you take in reducing costs, mitigating risks and driving continuous improvement in the value chain?
10. Future outlook.