THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

Levels of Interaction in Supply Chain Relations

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CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2007

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Research Series from Chalmers University of Technology
Department of Product and Production Development
ISSN 1652-9243
Report No. 23

Published and Distributed by
Chalmers University of Technology
Department of Product and Production Development
Division of Product Development
SE – 412 96 Göteborg, Sweden

Printed in Sweden by
Chalmers Reproservice
Göteborg, 2007

ABSTRACT

To be able to retain the manufacturing industry durably, in Europe in general and in Sweden in specific, manufacturing companies have to be competitive also on the global market. One way for companies to realize this ambition is to interact with suppliers and customers in different kinds of supply chains. In the dyadic relation between two companies, three different levels of interaction have been identified. To be able to enhance the competitiveness instead of requiring excess workload, the level of interaction has to be adequate for the specific company and their market conditions.

The aim of this thesis is to clarify the characteristics of supply chain interaction, both in terms of different levels of interaction and concerning the factors affecting the appropriate level of interaction. A basic prerequisite to enable companies to select an appropriate level of interaction within their supply chain is also to clarify the present use of terminology.

This research is conducted through theoretical studies. The theoretical findings are synthesized in order to fulfill the research objective.

Characteristics of supply chain interaction in terms of affecting categories and factors are identified. The factors are sorted according to the category they support. An interaction framework that can be used to gain an overview over the categories and factors affecting the level of interaction in a specific situation is developed.

The resulting interaction framework is aiming at industry applicability but is based only on theoretical studies (which in turn are based on empirical data).

The aim is to support the interaction level decision for, primarily, small and medium sized manufacturing companies in order to increase their competitiveness.

Despite the amount of research within the supply chain area, the question how companies should select the way to interact within their supply chain has so far been left unanswered. In this thesis, a number of categories and factors that affects the appropriate level of interaction are identified and listed.

Keywords: Supply chain, Dyadic relations, Collaboration, Levels of interaction, Interaction framework

ACKNOWLEDGEMENTS

Finally! It is nice to at last have created something tangible to show to my friends and loved ones, that time after another have heard my excuse – "Snart, jag ska bara…".

Writing an academic thesis is not always an easy endeavor, or as two exchange students I have supervised expressed – "It is very hard to find information when you are looking for something specific". The PhD candidates at our department however, have developed this thought further – "It is very hard to find information when you don't know what you are looking for".

I would like to thank both past and present colleagues at the Department of Industrial Engineering and Management at School of Engineering, Jönköping University, for creating a workplace to long to. The members of the Italian Sports Car Club have also contributed to this feeling.

I would especially like to thank Carin for fruitful discussions and thorough feedback on a late draft of this thesis. I would also like to express my gratitude to Dr. Michael for creating this handy word template.

My supervisors, Christer Johansson and Kristina Säfsten, deserve special recognition, as does Joakim Wikner who entered at a late stage in this thesis project. Thank you all for wise and insightful comments.

Jenny

Jönköping, April 2007

PUBLISHED PAPERS

The following published and appended papers constitute the basis of this licentiate thesis. The paper denotations and references are followed by a description of the author's contribution.

Paper 1 – Bäckstrand, J. and Sandgren, A., (2005) A review of Supply Chain Classifications, *Proceedings from PLAN2005 7th Research and Application Conference [Forsknings- och tillämpningskonferens],* August 18-19, 2005, Borås, Sweden.

Contribution: Bäckstrand and Sandgren initiated the paper. Bäckstrand wrote and presented the paper whereas Sandgren contributed with ideas of contents.

Paper 2 – Bäckstrand, J. and Säfsten, K., (2005) Review of Supply Chain Collaboration Levels and Types, *Proceedings from OSCM2005: Operations and Supply Chain Management Conference,* December 15-17, 2005, Bali, Indonesia.

Contribution: Bäckstrand initiated and wrote the paper. Säfsten contributed by improving the structure and readability of the paper.

Paper 3 – Bäckstrand, J. and Säfsten, K., (2006) Supply Chain Interaction - Market Requirements Affecting the Level of Interaction, *Proceedings from the 15th international IPSERA2006: International Purchasing and Supply Education and Research Association Conference,* April 6-8, 2005, San Diego, USA.

Contribution: Bäckstrand initiated, wrote, and presented the paper. Säfsten contributed by improving the structure and readability of the paper.

Paper 4 – Bäckstrand, J., (2006) Levels of interactions in Supply Chains, *Proceedings from PLAN2006 8th Research and Application Conference [Forsknings- och tillämpningskonferens],* August 23-24, 2006, Trollhättan, Sweden.

Contribution: Paper written as sole author.

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CHAPTER 1

INTRODUCTION

CHAPTER INTRODUCTION

Why should companies in a supply chain interact with each other? The reasons are many and in this chapter some of the motives for, and benefits of, interaction are presented. The background and objective of this thesis together with the research questions are presented. Finally, a presentation of the underlying publications is made, and the outline of this thesis is stated.

Regardless of origin, size, or trade it has become increasingly important for all companies to improve their competitiveness. When the distance between companies gets shorter due to technology improvements and it becomes just as likely to trade information and exchange goods with a company on the other side of the globe as with a neighbor, the available market expands. Another consequence is that even small local companies are exposed to international competition. If these companies fail to increase their competitiveness they are running a striking risk of getting driven out of business by competitors in low-wage countries.

Small and medium sized enterprises (SMEs) account for 99.8 % of all the enterprises in Europe and provide 69.7 % of the employment in the private sector (European Commission, 2003). Since so many people are employed by SMEs, a weakened competitive status of these companies with fewer working opportunities could have a negative effect on the economy and hence the society.

Small and medium sized manufacturing companies (SMMEs[1]) are in this aspect further affected, as it often is the manufacturing functions that are moved abroad. To be able to retain the manufacturing industry durably, in Europe in general, and in Sweden in particular, the many SMMEs have to be competitive also in the global market (Greatbanks and Boaden, 1998; Greatbanks *et al.*, 1998; Säfsten and Winroth, 2002). In Sweden, 11 percent of the SMEs are in the manufacturing industry (European Commission, 2006).

[1] A distinction is here made between small and medium sized enterprises (SME), which can include all forms of small and medium sized business activity, and small and medium sized manufacturing enterprises (SMME), which focuses entirely on manufacturing organizations.

1.1 INCREASED COMPETITIVENESS WITH SUPPLY CHAIN INTERACTION

How can then the competitiveness for SMEs and SMMEs be increased? One way for companies to realize the ambition of improved competitiveness is to cooperate with their suppliers and customers in different kinds of supply chains. The research on these interactions between companies in supply chains, often called 'supply chain collaboration', has lately attracted a lot of, at least academic, interest.

Since 'supply chain collaboration' is just one of the available terms to describe these interactions, this thesis will instead use 'supply chain interaction', unless the original author uses the 'supply chain collaboration' phrase.

According to Cravens *et al.* (1996), the question is no longer whether to establish relationships with other companies or not, but rather how, and with which companies. The benefits of interaction within supply chains has been emphasized by several authors (e.g. Christopher, 1998 p. 72; Horvath, 2001; Sahay, 2003). According to Bowersox (1990), the overall performance is improved by 'supply chain collaboration' since it facilitates the cooperation of participating members along the supply chain. Other examples of benefits from interaction include revenue enhancements, cost reductions, and operational flexibility to cope with high demand uncertainties (Fisher, 1997; Lee *et al.*, 1997; Simatupang and Sridharan, 2005). Both practitioners and academics are as a result of these potential benefits becoming more and more interested in supply chain interaction research (Corbett *et al.*, 1999; Horvath, 2001).

There are however, some flaws or "white spots" regarding the existing 'supply chain collaboration' literature both in terms of theory and in terms of application. Even though there is a substantial body of literature regarding supply chains and supply chain interaction, the relevance of this literature to the smaller manufacturer is less clear. The majority of the literature in the supply chain area appears to have been written either from the perspective of the larger multi-site manufacturing company, or without concern for the size and circumstances of the company (Greatbanks *et al.*, 1998).

There are also no uniform terminology describing the interactions between companies (Simatupang and Sridharan, 2005). For example, what defines collaboration (Mentzer, 2001)? What is the content of interaction? What is the extent of an interaction? What is being compared or analyzed? Should a company strive to transform all its interactions into collaborations? Thus, the terminology concerning supply chain interaction needs to be clarified and defined.

The intention of the majority of previous supply chain collaboration research has been to propose measures of the degree to which a company interacts with its partners in a supply chain, without considering what the content of the interaction actually is (Simatupang and Sridharan, 2005). How can one measure the degree of interaction when the variables are incomparable? Bengtsson *et al.* (1998, p. 75) for example define different types of collaboration as complete ownership, joint ownership, joint venture, long-term contract, purchase option, and short-term contract (where ownership and contract is compared). Webster (1992) proposes another definition with a continuum from pure transactions to fully integrated hierarchical firms. Both these definitions include ownership and Webster includes pure transactions, which cannot really be considered as collaboration.

Interaction is hence not a panacea with a "one size fits all" approach. Instead, the most appropriate relationship is the one that best fits the specific set of circumstances (Cooper and Gardner, 1993; Lambert and Cooper, 2000). How companies should interact, with both

suppliers and customers, depends on the companies' prerequisites and the restrictions of the surroundings.

How a company's prerequisites and restrictions affect the company, was identified early (Forrester, 1958; Skinner, 1969). This knowledge has been widely applied when selecting or designing the internal manufacturing process (Hayes and Wheelwright, 1984; Miltenburg, 1995; Hill, 2000). These authors acknowledge that the selection of a manufacturing process is interlinked with the product characteristics or market requirements. A lot of literature has also covered different manufacturing strategies to create business opportunities (e.g. Hayes and Wheelwright, 1979; Wheelwright and Hayes, 1985; Pagh and Cooper, 1998; Hill, 2000). For example, the model by Hayes and Wheelwright (1979) supports the manufacturing process decision based on the product variety, volume, and uniqueness. Hill (2000) proposes a model for selecting the manufacturing process that best supports business and market requirements.

Furthermore, the research areas that refers to the flow of material to and from a company; supply, purchasing, inventory and materials management, and distribution logistics are also thoroughly covered in existing research (e.g. Mourits and Evers, 1995; Van Weele, 1996; Silver *et al.*, 1998; Arnold and Chapman, 2001). Traditionally however, each of the above mentioned areas have been treated, both in research and in industry, as individual departments with no or little communication in-between. This has led to, in most cases, deep and thorough research on how to improve each area. Even though this research is highly accurate, it leads to sub-optimization of the individual company instead of optimization of the supply chain.

For the supply chain interaction research, this implies that the internal and external contexts that affect the interaction are important areas to elucidate. In this thesis, the contexts treated in previous literature will be discussed. To assure that the interaction supports and increases the ability to compete, it is crucial that the interaction is arranged in an appropriate way and that it does not demand excess workload or resources from either participant.

The appropriate relationship for a company that manufactures and distributes a specific product is in this thesis assumed to be affected by a number of factors. The factors are for example associated with the external conditions given by a company's relations in the supply chain, the internal means, the product characteristics and the requirements of the market the product should compete in. This will be referred to as different categories to consider.

Each category consists of several factors and the purpose of this thesis is to identify both relevant categories and the affecting factors that are important for companies to be aware of.

1.2 RESEARCH OBJECTIVE AND RESEARCH QUESTIONS

The aim of this research is to improve the competitiveness of manufacturing companies, in particular SMMEs by supporting their selection of interaction level with suppliers and customers. This licentiate thesis constitutes the first step towards fulfilling the research aim.

The objective of this thesis is:

> To identify the key characteristics of supply chain interaction in order to develop an interaction framework, for selection of an appropriate level of interaction.

To be able to fulfill this objective the following three research questions have been formulated:

RQ. 1. What characterizes supply chain interaction?

When answering this research question, the concept of supply chains has to be clarified. The supply chain relations will be analyzed in order to see if there are different types and different levels of interactions. If so, what will then distinguish the different types from each other? What is the content of the interaction, what does it consist of? Could the terminology be made clearer?

RQ. 2. Which characteristics will affect appropriate level of supply chain interaction?

This will treat the categories that influence the company's possible supply chain interaction options. In addition, out of the possible ways to interact in the supply chain, which one is the most appropriate? To be able to determine that, each identified category will be operationalized into factors that can be measured or analyzed based on a specific company's prerequisites.

RQ. 3. How can the key characteristics be compiled in a comprehensive way that facilitates the applicability?

To contribute, both in academia and in industry, the characteristics have to be compiled and presented in a comprehensive way.

1.3 PUBLICATIONS

This thesis has two parts. The first part is an extended frame, consisting of the theoretical basis, analysis, and discussion. The frame also includes a summary of the content of previous publications. No direct references will be given to these publications in the frame, since the results in the papers are further developed in the frame.

The second part of the thesis are the previous publications that are appended at the end of this thesis, see Appended papers. These papers, and how they contribute to this thesis, are illustrated in Figure 1.1.

The first paper by Bäckstrand and Sandgren (2005) was based on a literature review investigating supply chain collaboration and supply chain classifications. It was concluded that, regardless of the abundant amount of research on supply chain collaboration, there was still a lack of supply chain models integrating the appropriate type of collaboration and the product characteristics.

In the second paper, by Bäckstrand and Säfsten (2005), the concept of level of interaction was introduced. It was also concluded that all interaction, irrespectively of supply chain context, starts with a dyadic relation. Some factors enabling higher levels of interaction were presented, together with some of the relational factors affecting the supply chain interaction.

The third paper by Bäckstrand and Säfsten (2006) regarded how the market requirements affected what level of interaction that was most appropriate. Market requirements in terms of competitive priorities and order winners were discussed.

In the forth paper by Bäckstrand (2006) the current inconsistency of terminology within the supply chain interaction area was pointed out. In addition, the resulting problems, when different units of analysis are put on the same scale and compared, were highlighted.

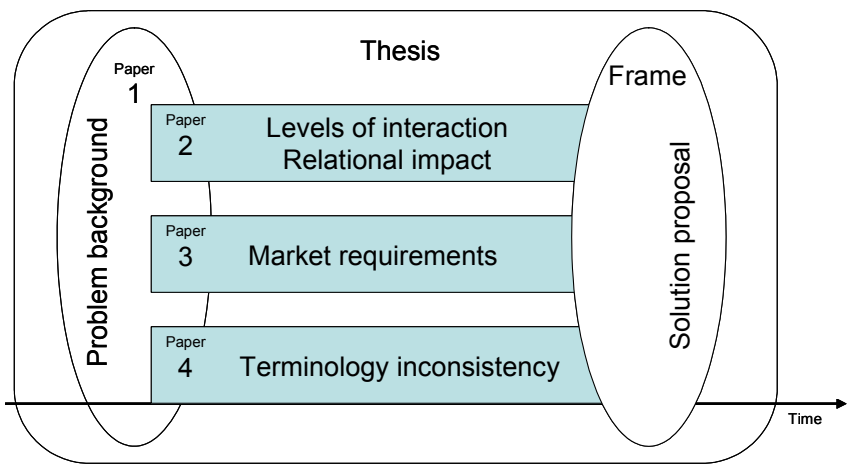

Figure 1.1 An illustration of how the papers contribute to this thesis

1.4 THESIS OUTLINE

This thesis constitutes a first step in a research project, and the outline of the thesis might hence not be conventional. This thesis outline is therefore intended as a road map to guide the reader through this thesis.

In this thesis, the key characteristics of supply chain interaction, as previous researchers and authors have defined them, are identified in a literature study. The identified characteristics, the factors and categories, and the interaction framework does not claim to be applicable for SMMEs at this stage, since most of the previous research has either regarded large enterprises or have not stated the size of their study object.

In the next step in this research project, these theoretically defined characteristics will be tested towards SMME validity. The theoretically defined factors and categories will also be tested for validity, and the resulting interaction framework will be tested for applicability.

The outline of the following chapters is as follows:

Chapter 2
RESEARCH APPROACH

This thesis is based on a theoretical research approach. In this chapter, the theoretical underpinning, for the used systems approach and bottom-up perspective, applied in this research is presented. The chapter also includes a methodological evaluation of the research approach.

Chapter 3
SUPPLY CHAIN FUNDAMENTALS

The foundation for this thesis is laid in this chapter. Since the supply chain interaction takes place in the context of a supply chain the main properties of a supply chain, as used in this thesis is stated. The basic building blocks of the physical supply chain are defined, different types of supply chain interaction are presented, and the supply chain interaction terminology is clarified. Theory and analysis are combined through out this chapter in order to make continuous definitions and delimitations of supply chain interaction.

Chapter 4
FACTORS AFFECTING LEVEL OF INTERACTION

The fundamentals of the supply chain was established in the previous chapter, this chapter however, concentrates on the interaction related properties. The categories to consider and the factors affecting level of interaction are derived from existing literature. Also in this chapter, theory and analysis are combined in order to evaluate/compare the presented theories with the research aim. In the existing literature, both factors and structures are defined. The aim of this chapter is hence to identify as many factors as possible, but also to identify a structure, suitable for basin an interaction framework on. The factors are subsequently categorized according to what category they belong to.

Chapter 5
INTERACTION FRAMEWORK DEVELOPMENT

Using the structure and the identified categories and factors, an interaction framework is developed and presented. The structure is based on the 'profile analysis structure'. The framework is intended as a managerial tool and the chapter is hence concluded with an instruction of how to use the interaction framework.

Chapter 6
DISCUSSION AND FUTURE RESEARCH

To conclude this thesis a discussion is included of the degree to which the research has answered the research questions and has fulfilled the research objective and aim. The implications and intended direction for future research within the research project are also stated.

CHAPTER 2

RESEARCH APPROACH

CHAPTER INTRODUCTION

In this chapter, the methodological issues are discussed in order to clarify the basic assumptions made in this thesis. Successively, the scientific perspective, the research design, and the research design evaluation are considered.

2.1 SCIENTIFIC PERSPECTIVE

There are three alternative perspectives of reality within the business research today (Arbnor and Bjerke, 1997). These are:

- the analytical approach
- the systems approach
- the actors approach

These approaches differ in how they view reality. The oldest approach is the analytical approach. Its assumption is that the whole is the sum of its parts, which implies that each difficulty can be divided into as many parts as might be possible and necessary in order to solve it (Checkland, 1998, p.46). The analytical approach is based on the positivistic research tradition, where general laws are sought and hypotheses are formulated and tested (Säfsten, 2002, p.19). Chronologically, the system approach comes next. It was developed as a reaction to the summative view of reality in the analytical approach. According to the systems approach the whole is different from the sum of its parts. To aim for a holistic view is very popular and system thinking is hence the dominant view, both in business theory and business practice. A factor that has been important for the growth of the systems approach is the need for interdisciplinary approaches to solve increasingly complex social problems (Arbnor and Bjerke, 1997, p. 135). The third approach, the actor approach, is the most recent of the three. It emerged at the end of the 1960's. In the actors approach wholes and parts are ambiguous and the reality is instead seen as a social construction (Arbnor and Bjerke, 1997).

The analytical approach is somewhat tempting in this research since the complex reality or a comprehensive supply chain network can be difficult to grasp. The systems approach is nevertheless the most suitable approach for meeting the stated research objective and will hence be further investigated. This is also supported by for example Christopher (2005, p.5) who states that 'the whole can be greater than the sum of its parts' when supply chain relations are properly managed.

2.1.1 System approach

The view within the systems approach is, as stated previously, that the whole [system] is different from the sum of its parts. Important to point-out is that this synergy effect could be either positive or negative (Arbnor and Bjerke, 1997, p. 51).

Systems' thinking is a way to understand the complexity of the world. The concept 'system' embodies the idea of a set of elements connected together, which forms a whole. Systems thinkers whish to describe the world holistically - in terms of whole entities linked in hierarchies with other wholes (Checkland, 1998). This thought was also presented by Seliger *et al.* (1987) who distinguishes between three different system aspects; functional, structural, and hierarchical, see Figure 2.1.

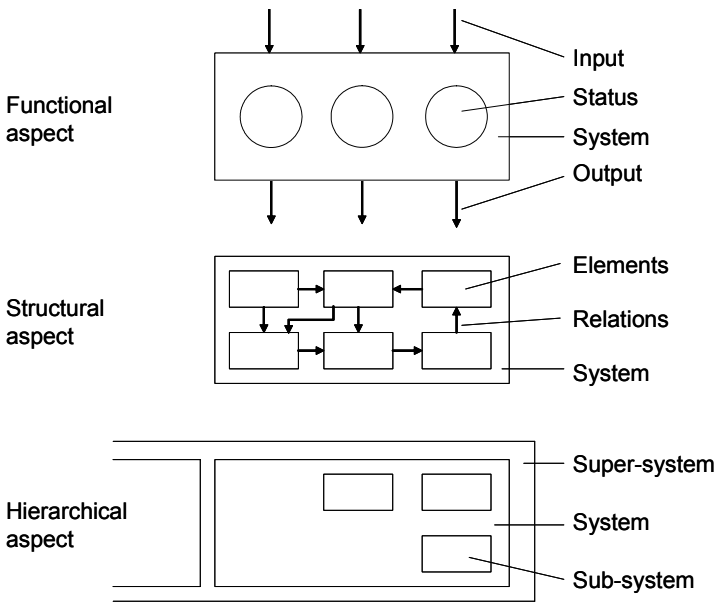

Figure 2.1 Different system aspects (Seliger *et al.*, 1987)

- In the functional aspect the behavior of a given system is described independently of its realization (Seliger *et al.*, 1987). The function of the system describes the purpose of the system (Hubka and Eder, 1988).
- The structural aspect describes a system as a set of elements that are interlinked with relations (Seliger *et al.*, 1987). The relationship between different entities is essential, and the entities should be explained and understood from the properties of the whole (Arbnor and Bjerke, 1997).
- According to the hierarchical aspect parts of the system can be considered as sub-systems and the system itself can be part of a more comprehensive system – a super-system (Seliger *et al.*, 1987).

A system can also be classified according to if it is an open system or a closed system. An open system depends on its surroundings/environment/context, which makes the relation between

the system and its context interesting to study. A closed system is not influenced by, and cannot influence its surroundings (Arbnor and Bjerke, 1997, p. 112; Bellgran and Säfsten, 2005, p. 60).

According to Mattsson (1999, p. 47), companies and supply chains can be regarded as open systems since their components are linked, not only to each other, but also to the surroundings, i.e. suppliers, customers, competitors, and the authorities. The sub-systems in a company can for example be the functions within the company that add value to the product. The sub-systems in a supply chain system are then the individual companies.

Besides the system aspects, two alternative procedures are presented by Seliger *et al.* (1987) describing the system in a complete and clearly structured way: the top-down procedure and the bottom-up procedure. The top-down procedure starts from the description for the whole system and refines the structures down to a detailed solution. The bottom-up procedure starts from the sub-system and combines several sub-systems to build a system or a super-system. The bottom-up procedure is more often applied than the top-bottom procedure even though it does not support the system approach as well as the latter does (Seliger *et al.*, 1987, p. 223).

2.2 RESEARCH DESIGN

The results presented in this thesis are based on theoretical studies and literature reviews. A literature review is a systematic, explicit, and reproducible method for identifying, evaluating, and interpreting the existing body of literature (Fink, 1998). A literature review can be used to identify what is known and not known to justify the need for further studies to fill in the gap (Fink, 1998).

According to Hart (2001), books, articles, conference papers, statistics, official publications, reports, and theses are an appropriate literature base for a thesis at a doctoral level. The type of literature to use depends on the aim of the literature review. In books, theories and models are often presented in a fuller context and in more detail. The latest findings are instead found in articles, reports and conference proceedings (Patel and Davidson, 1994, p. 33; 2003, p. 42).

The literature within the supply chain area is rather widespread concerning from which perspective supply chain collaboration or supply chain interaction is regarded. Few, if any, articles define the extent or context of supply chain collaboration or the content of collaboration (what is consists of, what is being exchanged). The article selection is thus deliberately multi-disciplinary in order to identify the contrasting themes and antecedences of the field. The references used in this research are extracted from areas such as supply chain management, logistics, systems theory, operations management, manufacturing strategy, and organizational theory.

The selection of literature to review is iterative. When an article is found relevant, the reference list can be used to trace the original source and/or other articles covering this subject, which is a established way of finding relevant literature according to Patel and Davidson (1994, p. 34)

The aim of this thesis is theory development, resulting in an applicable framework for industrial and academic use. The research is therefore striving to be normative, i.e. it will not describe how the level of interaction is decided, but rather how it should be decided (Hart, 1998; 2001).

Furthermore, Croom *et al.* (2000) concluded, based on an extensive literature review that the supply chain literature is dominated by descriptive empirical studies and only 6 % of the

articles concern normative theoretical studies. This thesis will therefore aim at contributing to the creation of consistent theory.

The literature found in a literature review should be filtered through two eligibility screens; the practical screen and the quality screen (Fink, 1998). The practical screen identifies studies that are potentially usable and the quality screen checks for adherence to methods that scientists and scholars rely on to gather sound evidence.

In this literature review, the practical screen was only used to identify literature written in English or Swedish. Books, academic journals, business journals, conference proceedings, and theses were included while newspapers were excluded. No limitations regarding when the literature was from were set, both the initial reference and the latest findings were considered relevant.

The quality screen methodology can be used to select and review only the literature that meets the selected standards. Within the supply chain area however there is no clear definition of how high-quality studies should be conducted. No literature has hence been excluded on this basis.

2.2.1 Research evaluation

To be able to determine if the facts found in a literature review are probable, the researcher has to remain critical to the underlying documents. Patel and Davidson (1994) have compiled the following list of critique of sources a researcher should be aware of.

- When and where were the documents created? During, or long after the event occurred?
- Why was the document created? What was the author's aim? Under what circumstances was the document created?
- Who is/was the author? What was the author's relation to the event? What is the viewpoint of the author, is it a practitioners view or an academic view?

As with all secondary information, it is hard or impossible for the reader to distinguish between the facts from an event and the author's interpretation of the event. Literature with a thorough methodological description at least gives the reader a chance to analyze if the author has considered this problem when writing the literature.

Another source of errors when conducting literature reviews is connected to the selection of literature to include in the review and in the theoretical framework.

2.2.2 Literature selection

There are, according to Thurén (1997), no specified, commonly accepted rules for selection of data – outside the area of statistics. This does not mean that sources can be selected on pure arbitrariness. In order to claim research validity, the sources have to be selected in a structured way to give a correct picture of reality. Since there are no clear boundaries between a correct selection and a distorted selection, Thurén has developed three rules of thumb to help writers make correct selections:

1. A selection is distorted if data, that is relevant from the chosen perspective, is withheld.
2. A selection is distorted if the person, accomplishing the selection, has reasons to hide how the selection was made.
3. A selection is distorted if additional data could change the general picture.

In this research, the first two issues are regarded throughout the selection process. The last issue, however, is less complied since this research only includes some of the perspectives of supply chain interactions; areas such as psychology and transportations that could affect the relations are not regarded in this research.

CHAPTER 3

SUPPLY CHAIN FUNDAMENTALS

CHAPTER INTRODUCTION

In this chapter, the basis for the rest of this thesis is established. The basic building blocks of the physical supply chain are defined, the different types of supply chain interaction are presented, and the supply chain interaction terminology is clarified. To conclude, the concept of different levels of interaction is introduced.

3.1 SUPPLY CHAIN DEFINITIONS

A basic requirement when trying to elucidate the supply chain collaboration and supply chain interaction terminology is to clearly state the extent of the supply chain and the relation that is being treated. This has unfortunately often been omitted in previous research. The research area by no means lacks definitions; the problem is rather the abundance of definitions and that they sometimes even are contradictory.

3.1.1 Supply chain and supply chain management

Despite the popularity of the supply chain management concept and the supply chain management term in both academia and in practice, there is still a considerable confusion to its meaning (Mentzer *et al.*, 2001; Chen and Paulraj, 2004). Some authors have defined supply chain management in operational terms, others as a management philosophy and some as a management process (Tyndall *et al.*, 1998). It has also been defined as the management of supply relationships (Harland, 1996; Christopher, 2005) and as an approach to deal with planning and control of the materials flow from suppliers to end users (Ellram, 1991).

The terms supply chain and supply chain management are sometimes used interchangeably, but will here represent different research areas. Since the scope of this thesis is interactions within supply chains - consequently, both the physical supply chain where the interaction takes place and the interaction *per se* will be studied and analyzed. Previous literature regarding both these areas are hence of interest.

Supply chain has been defined as: *"A set of three or more entities (organization or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from source to a customer"* (Mentzer *et al.*, 2001, p. 4).

Or as *"The global network used to deliver products and services from raw materials to end-customers through an engineered flow of information, physical distribution, and cash"* (APICS Dictionary, 2005, p. 113). A network is then defined as: *"A graph consisting of nodes connected by arcs"* (APICS Dictionary, 2005, p. 73).

Christopher (1992, p. 12; 2005, p. 17) defines the supply chain as: "*The network of organizations that are involved trough upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hand of the ultimate consumer".*

This thesis will adhere to the basic definition by Mentzer *et al.* (2001, p. 4) stating that *"supply chains exists whether they are managed or not"*. The definition of supply chain, and what it consists of, will be further analyzed later in this chapter.

Mentzer *et al. (2001, p. 18)* have tried to develop a single encompassing definition of **supply chain management** and ended up with: "*supply chain management is defined as the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.*

Supply chain management was regardless of this attempt defined by Christopher (2005, p. 5) as: *"The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole."* Christopher further argues that supply chain management focuses on the management of relationships.

The supply chain management definition by Christopher (2005) is also not universally accepted. The definition presented in the APICS Dictionary (2005, p. 113) does not mention relationships at all: *"The design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally."*

The purpose of this thesis is not to develop yet another definition of supply chains or supply chain management, but rather to elucidate the lack of common definitions. To be able to achieve the aim of this thesis, that regards relations in supply chains, the interpretation of supply chain management will be closer to Christopher's definition than to the definition in the APICS Dictionary and Mentzer *et al.*

First, the terminology concerning supply chain and supply chain interaction that will be used onwards has to be defined.

3.1.2 Supply chain interaction terminology

As mentioned in the introduction chapter, the terminology is not consistent within the supply chain area. The current terminology inconsistency is threefold:

1. Different words are sometimes used to differentiate between different specific phenomenon and parts of the supply chain or supply chain management (e.g. Kahn and Mentzer, 1996).
2. Different words are sometimes alternately used to describe the same phenomenon, just to vary the language (e.g. Persson and Håkansson, 2006).
3. Words can include or mean different things and what the author has interpreted into the word is seldom stated. For example, is there any distinct difference between cooperation and collaboration?

Another problem with the inconsistent use of terminology is that it creates unnecessary confusion for the reader. The need for developing a consistent terminology has in fact been emphasized previously (e.g. Cooper *et al.*, 1997b; Skjøtt-Larsen, 1999; Mentzer *et al.*, 2001; Larson and Halldorsson, 2004).

The terminology inconsistency is even worse when the supply chain collaboration area is considered. Supply chain collaboration presumably treats the collaborative relations in a supply chain, but the content or extent of supply chain collaboration is rarely stated (e. g. Ireland and Crum, 2005).

Even though this inconsistency in terminology exists, several authors have attempted to provide technical solutions for collaboration strategies (Holweg *et al.*, 2005) or collaborational concepts (Skjøtt-Larsen, 1999) without stating for which type of supply chain or interaction these strategies and concepts are appropriate. The research findings, even though relevant, are consequently not directly applicable to other companies.

Some of the terminology used in existing supply chain collaboration research is presented in Table 3.1 together with their synonyms (where applicable) and explanations. The synonyms and explanations originate from the Encarta Dictionary (2007), the APICS Dictionary (2005), and from Merriam-Webster's Collegiate Dictionary (2007).

Table 3.1 *S*upply chain collaboration words, their synonyms and explanation

Word	Synonyms (example)	Explanation
Relation	Connection, association relationship	The attitude two groups assume towards another
Relationship	Association, connection, affiliation, bond, liaison, link, correlation	Connection or association; the condition of being related
Interact	Interrelate, act together, cooperate, intermingle	To act upon each other; as, two agents mutually interact
Interaction	Contact, interface, relations, communication	Mutual or reciprocal action or influence
Collaborate	Cooperate, team up, work together	To work together with others to achieve a common goal
Collaboration	Association, relationship, partnership, alliance, cooperation	The act of working together with others to achieve a common goal
Cooperate	Collaborate, help, mutual aid, assist	To work together, especially for a common purpose or benefit
Cooperation	Collaboration, assistance, help, support, teamwork	Association of persons for common benefit
Associate	Connect, relate, link, unite, combine, join together	A person united with another or others in an act, enterprise, or business; a partner or colleague
Interconnection	-	Specific business relationships that in various ways both affect and are affected by the interacting parties' other relationships
Interdependence	-	Mutually dependent; reliant on one another
Integration	Incorporation, assimilation	The act or process of making whole or entire
Alliance	Association, pact, treaty, coalition, union, grouping	A connection of interests between states, parties, companies etc.
Partnership	Joint venture, affiliation, enterprise, corporation	The state of being associated with a partner. An association of two or more people to conduct a business
Joint venture	Enterprise, corporation	Capital invested in the shared ownership element of new or fresh enterprise
Merger	Fusion, joining, unification, combination	Absorption by a corporation of one or more others
Acquisition	Purchase, acquirement, procurement	The act of acquiring
Transaction	Deal, business, matter, operation	A deal or business agreement. An exchange or trade, as of ideas, money, goods, etc.

This thesis cannot influence previous research but in order to, at least, not increase the terminology confusion the same word will consistently be used to describe the same phenomenon henceforth.

When discussing relations in supply chains the term 'supply chain collaboration' is often used. This is however problematic since collaboration is a word that has a positive charge, and far from all relations are positive, see for example adversarial, arms-length relation etc.

In this research, the words *relation* or *relationship* are used in the wider sense, to indicate any link between two companies, regardless if the link is active or not, and regardless if the interaction is adversary or amiably. Relations are hence something that always exists. The term *interaction* is used when the relation is mutual and the companies have some kind of contact. Interaction is hence used to describe the content of the relation. *Collaboration* is here merely one of the levels of interaction. These three words put in relation to each other are illustrated in Figure 3.1.

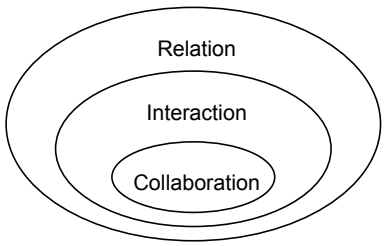

Figure 3.1 Terminology definition

In this thesis, the concept of supply chain interaction will hence be used when discussing the relations in a supply chain. Interactions with a negative charge are termed *adversarial* and relations with positive charge are called *cooperative*. The term interaction is regarded as being non-charged. The term 'supply chain collaboration' will consequently not be used henceforth, unless the original author uses that phrase.

3.2 THE SUPPLY CHAIN

The first step in managing the supply chain, as well as studying the relations within, is to map the supply chain structure (Lambert, 2006, p. 21). The outline of this sectionr is as follows:

- Supply chain components – here the basic building blocks of the supply chain are defined. In the definitions above, these blocks were termed entities, organizations, networks, and individuals. The connections between the blocks were termed linkages or relationships.
- Supply chain classifications – the view of supply chains at different abstraction levels are presented here.
- Supply chain view – at each abstraction level the supply chain can be viewed from a focal firm perspective or a customer perspective.
- Supply chain flows – here the 'upstream and downstream' flows mentioned in the definitions previously will be described further.
- Supply chain networks – a complex but holistic view of the supply chain at a high abstraction level is presented last in this chapter.

3.2.1 Supply chain components

According to Lambert *et al.* (1998, p. 4), a supply chain consists of the network of members, and the links between members of the supply chain. Harland (1996, p. 67) on the other hand defines a supply chain network as comprised of a set of persons, objects or events, called actors or nodes. Within the industrial network approach actors, activities, and resources are identified (Håkansson and Snehota, 1989; Håkansson and Johansson, 1992). Most authors agree that the basic building blocks of a supply chain are the nodes and the arcs between the nodes; the problem is however to agree on what these nodes and arcs represent. There is hence a need for defining these components of the supply chain further.

The *nodes* have previously been defined as different companies (Lambert *et al.*, 1998), different organizations (e.g. Håkansson and Snehota, 1989; Christopher, 2005), different juridical units (with different ownership) (Mattsson, 1999, p. 37), different geographical locations (Ferdows, 1997), different entities (organizations or individuals) (Mentzer *et al.*, 2001), or different actors (Mattsson, 1999, p. 37).

These definitions do however, not cover all situations. This was identified by Bäckstrand and Stillström (2007) when the level of interaction for mobile manufacturing units were analyzed. A mobile manufacturing unit is the same juridical and organizational unit as a stationary factory; they can have the same or separate geographical placement, and the ownership of the mobile manufacturing unit can be the same as the stationary factory or it could be a joint venture between the stationary factory and another owner. The mobile manufacturing unit and the stationary factory should still be represented as two different nodes in the supply chain structure.

The term 'actor' could hence be used if the content of an actor is defined. Each actor is thus here defined as a specific set of resources, regardless of ownership, location etc.

The *arcs* in the supply chain structure have previously been defined as an interdependence between actors (Mattsson, 1999, p. 37), as process links (Lambert *et al.*, 1998), as relationships (Håkansson and Snehota, 1989; Christopher, 2005, p. 5) as linkages with processes and activities (Christopher, 1992), or as flows of products, services, finances, and information (Mentzer *et al.*, 2001).

The arcs in the supply chain are in this thesis defined as the relations or *interactions* between the actors. There are no resources operating *on* the arcs and the interaction exists regardless if there currently is a flow, process, or activity between the nodes.

The basic components of the supply chain structure have now been defined; the next step is to investigate the different ways of viewing the supply chain – the different supply chain classifications.

3.2.2 Supply chain classifications

Even though most supply chain classifications originate form the management of supply chains, the same system levels are relevant when determining the scope of supply chain interaction in accordance with Christopher (2005). This is consistent with the definition by Mentzer *et al.* (2001, p.4) stating that supply chains are simply something that exist, while supply chain management requires clear management efforts by the organizations within the supply chain.

The research within supply chain management can according to Harland (1996), be divided into four different system levels, see Figure 3.2. These system levels will serve as reference when discussing supply chain interaction.

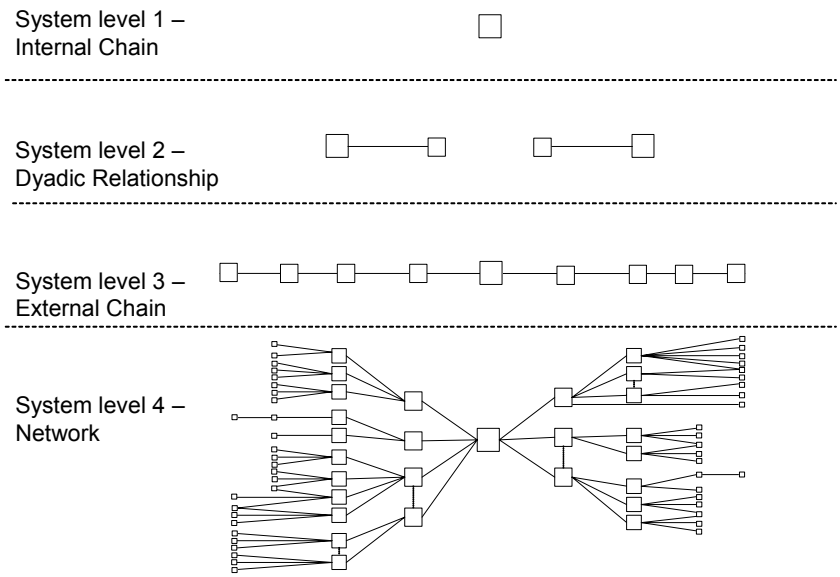

Figure 3.2 The system levels of supply chain management[2] (Harland, 1996)

The system levels are according to Harland (1996):

- System level 1 - The internal chain within an organization.

The inter-organizational relations can then be divided into three different system levels:

- System level 2 - The dyadic or two party relation.
- System level 3 - The external chain where the supplier, the supplier's suppliers, the customer, and the customer's customers are included, i.e. a set of dyadic relations.
- System level 4 - The network of interconnected chains.

This is however not the only available supply chain classification. Another classification is made by Hulthén (2002), originating from Alderson (1965):

- The transformation - A change in the physical product.
- The transaction - An exchange agreement between two actors.
- The transvection - The outcome of a series of transactions, related to all the activities required to place an end-product in the hands of a unique end-user.

There are many similarities between Harland's and Alderson's classifications, as can be seen in Table 3.2. The transformation process is similar to the internal chain, the transaction is similar to a dyadic relation, and the transvection is similar to the external chain. The fourth system level, the network level according to Harland, has no parallel in Alderson's classification. However, the same phenomenon is described by Hulthén (2002) and is then called "crossing transvections". Compare that to the definition of supply chain networks in

[2] The larger squares indicated the focus, or point-of-view, at each system level.

Harland *et al.* (1993, p. 19; 2001, p. 22) where supply chain networks are defined as a set of interconnected supply chains, and the conformity is complete.

The three inter-organizational system levels could also be seen as a sub-system, system and a super-system in accordance to the systems approach, see section 2.1.1 above.

Mentzer *et al.* (2001) propose a three-step classification, similar to Harland's, except that they exclude the internal chain and have a triadic relation instead of dyadic as their first level. The triadic relation includes the immediate supplier, the focal firm, and the immediate customer. They too support the notion of evolution from simpler setups towards more complex ones (Sørensen, 2005).

Besides the four basic system levels, three other ways of viewing supply chains have been identified; the relationship portfolio that can be seen as a development of the dyadic relation (Möller and Halinen, 1999; Johnsen and Howard, 2006), industries as networks (Möller and Halinen, 1999; Johnsen and Howard, 2006) and clusters or nets (Porter, 1990; Möller and Halinen, 1999; Möller *et al.*, 2005; Walters and Rainbird, 2007). In Figure 3.3 the 'relationship portfolio' and the 'industry as network' are illustrated. The third view, clusters or nets, is not illustrated since the original authors do not present any illustration.

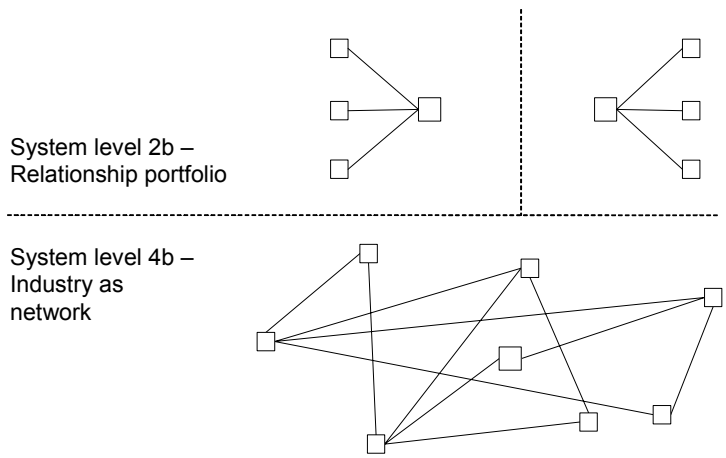

Figure 3.3 Two additional supply chains types in relation to Harland's system levels

A summary of different supply chain classifications, based on Harland's system levels, is presented in Table 3.2.

Table 3.2 Correspondence between different supply chain classifications

	Intra-organizational	Inter-organizational				
Author(s)	Internal chain System level 1	Dyadic relation 2	Relationship portfolio 2b	Chain 3	Network 4	Extended network 4b
Harland (1996)	Internal chain	Dyadic relation		External chain	Network	
Alderson (1965)	Transformation	Transaction		Transvection		
Hulthén (2002)	Transformation	Transaction		Transvection	Crossing transvection	
Johnsen and Howard (2006)		Dyadic exchange relationship	Relationship portfolio	Supply chain	Focal firm supply network	Industry as network
Mentzer *et al.* (2001)		(Triadic relation) Direct SC		Extended SC	Ultimate SC	
Möller and Halinen (1999)		Exchange relationship	Relationship portfolio		Firms in network	Industries as networks

Common to all the presented classifications, a clear distinction is made between the intra-organizational and the inter-organizational relations. Intra-organizational relations, or the internal supply chain as it will be referred to onwards, integrate the business functions needed to create a flow of materials and information from the inbound to the outbound ends of one actor (Harland, 1996). The inter-organizational relations, or the external supply chain, focus on the relations between different actors. The actors could hence be different entities of the same company or juridical unit.

3.2.3 Supply chain view

One of the actors in a supply chain is usually viewed as the central actor, see Figure 3.4. This is usually the main company in a supply chain from a key product perspective. This is often a manufacturing firm, even though a powerful retailer can take on the same role. Alternative denominations for the central company is a focal firm or channel leader (Cooper *et al.*, 1997a), focal organization (Håkansson and Snehota, 1989), channel master, orchestrator firm, and supply chain master (APICS, 2005) or nucleus firm (Murphy, 1942). When an organization describes their own supply chain, they most often consider themselves as the focal firm in order to identify their suppliers and customers. The suppliers and customers in a focal firms supply chain are called the supply chain members.

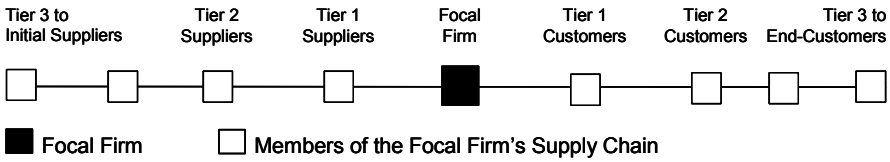

Figure 3.4 The supply chain structure with a supply-centric view

Constructing the supply chain from the focal firm outwards is referred to as taking a "supply-centric" view of the supply chain, see Figure 3.4. The other option is to instead adapt a "customer-centric" perspective where the supply chain is built from the customer backwards, see Figure 3.5 (Aitken *et al.*, 2005). Both these options correspond to Harland's third system level - the external chain.

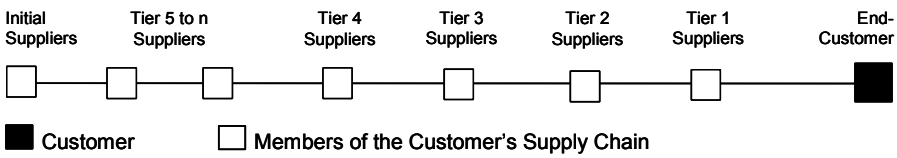

Figure 3.5 The supply chain structure with a customer-centric view

The end-customer can also be referred to as the consumer. The customers between the focal firm and the end-customers in a supply-centric supply chain are the intermediate customers. The tier 1 customers can also be referred to as the immediate customers (in a production context, or an internal chain the following production process can be the immediate customer of the current production process).

This way of illustrating supply chains are somewhat problematic since the supply chain always ends with an end-customer/consumer. The end-customer may also have outputs in the form of returns. These returns have to be handled and the return material constitutes the input to one of the upstream actors in the supply chain or input to an actor in a totally different supply chain.

3.2.4 Supply chain flows

The actors in a supply chain exchange materials, products, services, money, and information to create value for the end-customer. When the supply chain is observed on system level three and above, these exchanges form a flow, either from initial supplier to end-customer or vice versa. The direction of this flow is called the upstream or the downstream flow and usually refers to the direction of flow from the focal firm's point-of-view (Womack *et al.*, 1990; Christopher, 1998 p. 22; Womack and Jones, 2003). See Figure 3.6.

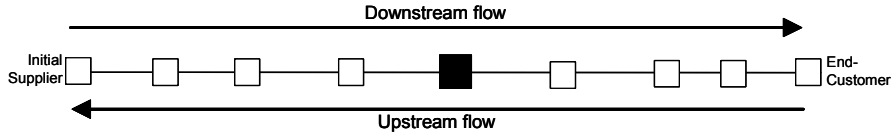

Figure 3.6 The upstream and downstream flow of a supply chain

The upstream flow mainly consists of information and finances but also products or material in the form of returns. The downstream chain, or the distribution channel, consists of the focal firm's customers and their customer's customer. The main content of the downstream flow is the flow of products or material, even though the flow of information is also important.

3.2.5 Supply chain network

When the complexity increases or when the focal firm wants to map its surroundings in a more complete or realistic way, the supply chain evolves into a supply chain network that can be defined as a set of interconnected supply chains, describing the total flow of goods and services from original sources to end-customers, from a focal firm's point of reference (Harland, 1996), see Figure 3.7. Instead of the linear and unidirectional model describing supply chains, the supply chain network concept includes and describes lateral links, reverse loops, two-way exchanges etc. (Lamming *et al.*, 2000). This corresponds to Harland's system level four.

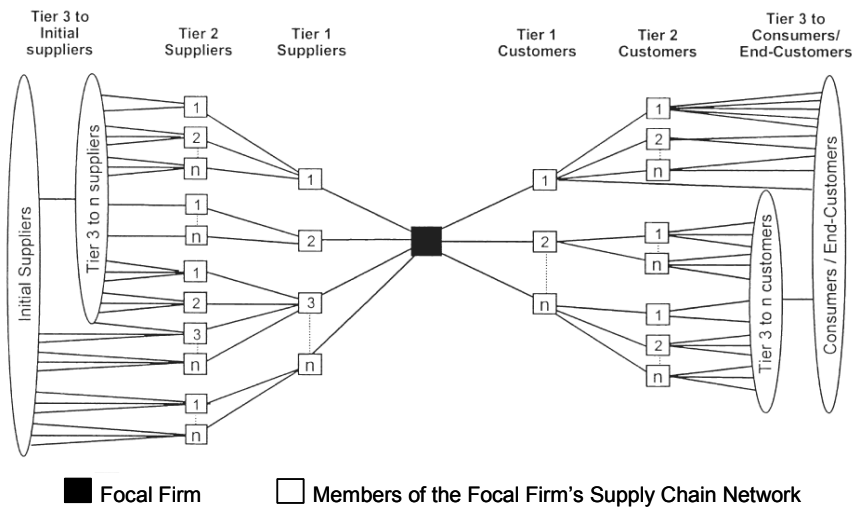

Figure 3.7 Supply chain network structure (Lambert *et al.*, 1998)

The most common way (e.g. Mattsson, 1999, p. 41; Brewer *et al.*, 2001, p. 119; Christopher, 2005, p. 5; Slack and Lewis, 2005, p. 153; Jahre *et al.*, 2006, p. 40) of illustrating the supply chain network corresponds to Figure 3.7 and is often accredited to Lambert *et al.* (1998).

There are however earlier references to a similar model called "the Deming Flow Model" in MacBeth and Ferguson (1994, p. 62). Deming himself states that this chart first was used [by him] in August 1950 (Deming, 1982, p. 4).

The illustration has probably gained its popularity due to its simplicity and generality. It has some pedagogical flaws though, which will be pointed out in section 3.3.1.

3.3 SUPPLY CHAIN INTERACTION

Next, the relations, or interactions, within the supply chain will now be further analyzed. The section is concluded with a definition of which entities that should be studied when determining the level of interaction in supply chains.

3.3.1 Direction of supply chain interaction

The relations in a supply chain are considered to range either vertically or horizontally. The vertical relation is a set of inter-organizational relations between actors in different tiers. The complete vertical chain links the initial supplier all the way to the end-customer. Vertical integration is when an actor increases its ownership to include other actors in different tiers. Vertical integration is usually focused either upstream towards the initial supplier or downstream towards the end-customer (Christopher, 2005, p. 17). In order to get the illustration of the vertical integration vertical, and to let the downstream flow actually flow downstream, the previous figure (Figure 3.7) has to be tilted, see Figure 3.8.

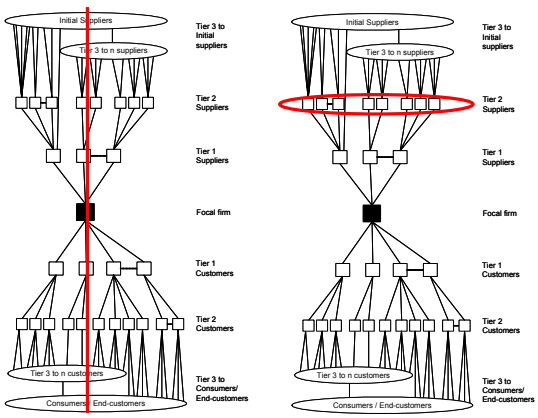

Figure 3.8 The vertical and horizontal relations, based on Lambert *et al.* (1998)

The horizontal relation is composed of relations within the same tier. Since the companies within the same tier play the same role in a supply chain, the relations are between actual or potential competitors (Cravens *et al.*, 1996). Why would any actor want to form alliances with similar actors competing on similar markets? The incentives for horizontal relations are, in fact, many. It could be the prospect of together being able to act as *one* towards a dominant supplier or customer. Together they could develop a particular technology (Hinterhuber and Levin, 1994). Another reason could be the ability to accept overwhelming orders by splitting

the workload, or it could even be the advantages of a cartel situation where it is no longer a customer's market.

In this thesis, no limitations regarding vertical or horizontal relations are made; relations in any directions are considered.

3.3.2 Different types of supply chain interaction

The intention of the majority of previous supply chain relation research has been to propose measures of the degree to which a company interacts with its partners in a supply chain, without considering what the content of the interaction actually is (Simatupang and Sridharan, 2005). This can probably be traced back to the terminology inconsistency. One resulting problem is that different units are put on the same scale.

A literature review has been conducted where previous authors view of different types of interaction have been analyzed. A compilation of the results can be found in Table 3.3 where, for instance exchange, contractual forms, time frame, and ownership are put on the same scale.

Table 3.3 Different types of Supply chain interaction

Author(s)	Low interaction							High interaction
Marshal (1923)	Market transactions							Vertical integration
Coase (1937)	Market-price mechanism							Coordinated firm
Blois (1972)				Vertical quasi-integration				Vertical integration
Richardson (1972)	Market transactions			Intermediate levels		Formally developed cooperation		
Ellram (1991)	Discrete transactional relationship	Cooperative under-standing	Long-term contracts					Ownership
Ellram (1991)	Transaction	Short term contract	Long-term contract			Joint venture	Equity interest	Acquisition
Webster (1992)	Transaction	Repeated transaction	Long-term relationship	Buyer-seller partnership	Strategic alliances	Network organizations	Vertical integration	
Leavy (1994)		Traditional perspective-competitors			The JIT perspective –partners			

MacBeth and Ferguson (1994)	Purchase order or spot market	Product life Partnership	Shared destiny Partnership	Minority shareholding	Strategic alliance	Joint venture		Merger or acquisition
Harland (1996)	Pure market			Supply chain management				Vertical integration
Harland (1996)	Purchase order or spot market	Product life Partnership	Shared destiny Partnership	Minority shareholding Partnership	Strategic alliance Partnership	Joint venture		Acquisition
Lambert *et al.* (1996)	Arm' s length transactions	Type I Partnership	Type II Partnership	Type III Partnership		Joint venture		Vertical integration
Cooper *et al.* (1997a)	Pure arm's length			Partnership		Extremely close B2B relations		
Bengtsson *et al.* (1998)	Short-term contract	Purchase option	Long-term contract			Joint ventures	Joint ownership	Complete ownership
Wilson (1999)	Transactional				Cooperative partnership			
Newman and Huang (2006)	No integration outside the function silos	Functional effectiveness	Cross-functional effectiveness	Supplier-customer effectiveness		Multi-tier effectiveness		Fully integrated supply chain

It is noteworthy that the majority of these authors place different factors on the same scale and compare them. The literature review in Table 3.3 showed that the following factors had been compared to each other:

- processes or activities
- time frame
- frequency of interaction
- market drivers
- strategic intention
- contractual form and level of trust

The factors used to distinguish between different types of interaction are presented next.

A deeper relation requires more integration of **processes and activities** according to Lambert *et al* (1996). This is also supported by Cagliano *et al.* (2004). The recent literature has in fact been focused on the integration of activities and information flows. Two different areas of inter-organizational integrations have been defined: operational and technical integration. Operational integration refers to the integration of activities such as planning production delivery and quality. Technological integration refers to cooperation in designing and developing new products. (Cagliano *et al.*, 2004, p.153). A compilation of business processes can be found in section 3.3.3.

Time frame is used as a unit of analysis by Ellram (1991), Webster (1992), Lambert *et al.* (1996) and Harland (1996). They all assume that relations will become strengthened over time. **Frequency of interaction** is somewhat connected to the time frame of the relation, and with the same assumption that the relation will become deeper with more opportunities to interact. This will however depend on the business area. In a business where the products have short life-cycles, two companies might interact very frequently under a short period of time, without any deeper relation evolving. The opposite situation might occur when the product life-cycle is long.

Market drivers and type of economy is another way to differentiate between types of relations, used by for example Leavy (1994) and Persson and Håkansson (2006). This is interlinked with the **strategic intention** of the interaction.

Contracts and trust are in some sense each other's opposites. With a low level of trust between companies the terms regulated in a contract is of immense importance. This is however not how contractual form is interpreted by most authors. Ellram (1991) for instance distinguishes between long term and short term contracts i.e., uses the time frame point-of-view.

What is being analyzed and compared within a relation is connected to the factors that can affect the interaction. It might however be hard to derive what the real reason for a change in relationship is due to. For instance, an interaction will most likely evolve or mature over time. Is this relational transformation then due to the length of the relation, the frequency of interaction, the adaptation of resources, or due to the fact that the people within the organizations have gotten to know each other?

The factors: time frame, frequency of interaction, market drivers, strategic intention, contractual form, and level of trust are relatively straight forward, whereas processes and activities are not self-explanatory. Different types of processes will hence be described.

3.3.3 Business processes

Lambert *et al.* (1996) and Cagliano *et al.* (2004) stated that a deeper relation requires more integration of processes - but of which processes? As in previous sections, different authors have different suggestions. Within the supply chain management literature, three different process models are commonly referred to, see Table 3.4. One is the Supply Chain Operations Reference model (SCOR, 2003) that lists five different business management processes. Another model is developed by the Global Supply Chain Forum (Lambert *et al.*, 1998) and it consists of eight supply chain management processes. A third model, presented by Mentzer *et al.* (2001), covers ten business functions that can be viewed as processes.

Table 3.4 Business functions or management processes

Management processes (SCOR, 2003)	SCM processes (Lambert *et al.*, 1998)	Business functions (Mentzer *et al.*, 2001)
Plan	Customer relationship management	Marketing
Source	Customer service management	Sales
Make	Demand management	Research and development
Deliver	Order fulfillment	Forecasting
Return	Manufacturing flow management	Production
	Supplier relationship management	Purchasing
	Product development and commercialization	Logistics
	Returns management	Information systems
		Finance
		Customer service

So far, no limitations will be made concerning which model or which processes that will be covered in this thesis.

3.3.4 Supply chain interaction extent

The classifications and the system levels presented previously will serve as a basis for defining the supply chain interaction extent of this thesis.

The supply chain extent was basically divided into internal or external supply chains where the external chain varied in number of participants from a dyadic relation between two companies to extensive networks with numerous participants (Cooper *et al.*, 1997b). How about the extent of interaction in the supply chain? Is the extent of supply chain interaction related to the extent of the supply chain? The opinion regarding the extent of supply chain interaction varies in the literature.

According to Harland (1996), supply chain interaction focuses on the level of the dyad or two party relation in accordance with the system level definition. This is also supported by Mentzer *et al.* (2000) who claim that partnership is an inter-organizational entity developed between two independent organizations in a vertical relationship (see section 3.3.1) within a supply chain. Horvath (2001) on the other hand states that a strategic supply chain

management demands cooperation among *all* participants in the supply chain (which would correspond to manage all the actors in a network viewed at system level 3 or 4 in Harland's classification). Simatupang and Sridharan (2005) take a intermediate way and claim that supply chain interaction is defined as two or more supply chain members working together to create a competitive advantage through sharing information, making joint decisions, and sharing the benefits which result from greater profitability of satisfying end-customer needs than acting alone. Simatupang and Sridharan do however not state if these supply chain members are part of the internal or the external chain.

In this thesis, the definition of supply chain interaction extent will adhere to the definitions by Harland (1996) and Mentzer *et al.* (2000) i.e. supply chain interactions will be analyzed in the dyadic relations in the supply chain. This is a bottom-up perspective that is consistent with the systems approach, even though a holistic view of system level 4, the network, would be more eligible.

The dyadic interaction can be with either a supplier or a customer. The interaction in this thesis will only be viewed and analyzed from one of the actor's point-of-view – the focal actor; this is illustrated in Figure 3.9. This research will consequently only treat one dyadic relation at a time. The first reason for this delimitation is that only each individual actor can know its expected outcome and the strategic intention of the relation is. The second reason is that the two actors will, most likely have different approaches to the relation. This does not restrict the possibility to analyze the relation from both actors point-of-view, as long as the researcher is aware that the analyses have to be done separately.

Figure 3.9 The dyadic relation from one actor's point-of-view

The motivation for focusing on only the dyadic relationship is that even if the supply chain concept embraces several actors, every single actor has to treat each relation (arch) to another actor as unique. As a result, supply chain interaction is comprised of a set of dyadic relations and each actor is likely to participate in several different relations. For each relation, the appropriate level of interaction should be regarded.

3.3.5 Supply chain interaction content

The units that are analyzed to determine appropriate level of interaction in this thesis are the business processes, see section 3.3.3. Each dyadic relation constitutes several business processes and the different processes can have different levels of interaction within the same relation.

The level of interaction of each business process will however affect the over all level of interaction in a relation, and consequently the organization within each actor. When the level of interaction is low, the transaction of goods and money is handled by the seller at one node and the buyer at the other node (Cooper *et al.*, 1997a). All information is transmitted through these two filters in a serial communication structure (Mattsson, 2000; Slack and Lewis, 2005). This way of handling an interaction is traditionally referred to as "the bow-tie

approach" and is illustrated by two triangles meeting at a point, see Figure 3.10 (Christopher, 1998; Hoppe, 2001; Christopher, 2005). This analogy is based on Wal-Mart founder Sam Walton's bow-tie and diamond model which were used to change the historically adversarial relation between Proctor and Gamble and Wal-Mart to a more cooperative relationship (Cooper *et al.*, 1997a; Hoppe, 2001; Slack and Lewis, 2005)

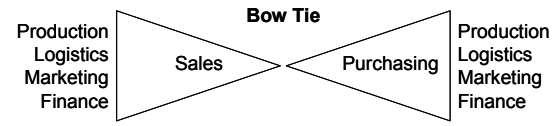

Figure 3.10 An illustration of the bow tie approach to relations (Cooper *et al.*, 1997a)

As the level of interaction gets higher, the triangles that represent the two companies rotate; consequently, each internal function gets closer to its corresponding function in the other node. The area of the surface where interaction is possible is thereby increased, and the communication structure becomes parallel (Christopher, 2000; Mattsson, 2000). The resulting relation is referred to as "the diamond approach" see Figure 3.11 (Cooper *et al.*, 1997a)

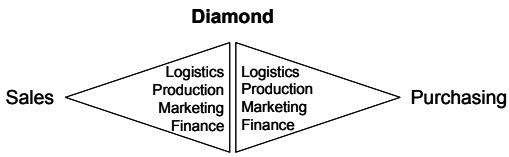

Figure 3.11 An illustration of the diamond approach to relations (Cooper *et al.*, 1997a)

The salesperson and the buyer may eventually disappear in this kind of relation since they become redundant. Both expected and serendipitous effects can occur from these closer relationships across multiple functions according to Pietro Romano, who is quoted in Slack and Lewis (2005).

Since the focus of this thesis is on the interaction between actors, and there are many simultaneous (contemporaneous) processes active at any time, it is important to point out that different processes can have different levels of interaction within the same dyadic relation.

3.4 LEVEL OF SUPPLY CHAIN INTERACTION

The degree of interaction between two actors can be described as a continuum, ranging from a single, non-repeated transaction to a full merger into one organization. Within this scale three different main *levels* of interaction are identified, namely transaction, collaboration, and integration. These three terms put in relation to each other and Figure 3.1, are illustrated in Figure 3.12.

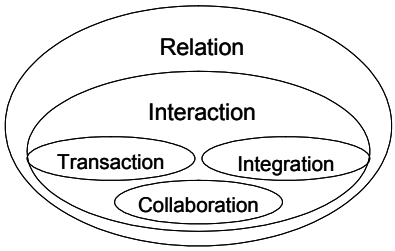

Figure 3.12 'Level of interaction' terminology

Each main level contains a continuum of relationship *types*, see Figure 3.13. In each dyadic relation and for each specific situation a certain level of interaction will be the most appropriate, regarding how much effort that is put in to the relation, and how big the yield is. The two actors in a dyadic relation can have different views of what level of interaction that is most appropriate, for them. This is important to acknowledge and keep in mind, but each relation will henceforth only be regarded from one actor's point-of-view, in accordance with the previous section.

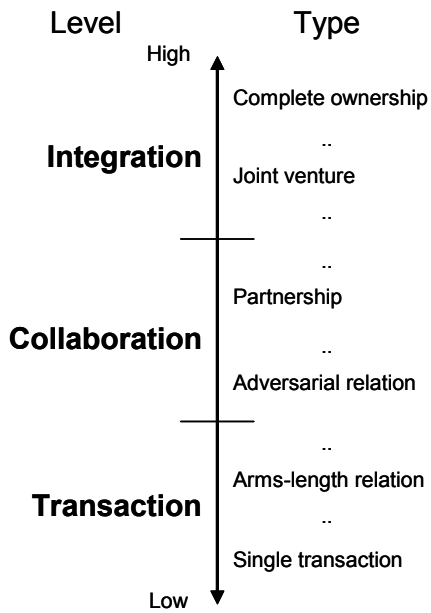

Figure 3.13 Levels and corresponding types of interactions

Supply chain interaction types associated with the transactional level of interaction are for example single transactions and arms-length relations. At the collaborative level of interaction, different degrees of cooperation can be found, from adversarial relations to partnership. When

the level of interaction gets higher the interaction type could be a joint venture, a strategic alliance etc.

Only when the differentiation between the *levels* of supply chain interaction is clear, supply chain interaction *types* can be discussed. It is however, not within the scope of this thesis to determine appropriate type of interaction.

3.4.1 Transaction

Transaction is commonly known as the exchange or transfer of goods, services, or funds. A transactional relation implies discrete exchanges of values, where a major issue is price (Achrol, 1991). A transaction that refers to the single product transaction[3] with limited information sharing was the dominant relation form during the 70's and 80's. These trade exchanges involved tough price negotiations where the supplier relation was adversary and the goal was to increase the individual actor's profit. Examples of terminology describing these relationship types are adversarial arm's-length and non-adversarial arm's-length (Cox, 2001a) or single and repeated transactions (Webster, 1992). These types of relations are characterized by distrust and competition (Skjøtt-Larsen, 1999). At the end of the 80's and during the 90's a change took place. Some of the previous competitive relations were replaced or supplemented by strategic partnership characterized by a high degree of information exchange (Skjøtt-Larsen, 1999).

3.4.2 Collaboration

To collaborate is generally defined as working jointly or cooperating with someone who one is not immediately connected to. Cooperating in its turn means to act or work together with others for mutual benefit. Examples of types of collaborative relations are adversarial collaborative or non-adversarial collaborative (Cox, 2001a), partnership (Webster, 1992; Mentzer *et al.*, 2000), and supplier-producer collaboration (Cravens *et al.*, 1996). In this thesis, as defined in section 3.1.2, collaborative interactions are assumed to be mutual.

3.4.3 Integration

Integration is usually defined as the incorporation of two units into one unit. Integration is in this thesis defined as the integration of one or many business processes between two actors. Ownership could be an enabler for an integrative relation, but is not a requirement. The reasons for this distinction between interaction and ownership is due to that joint ownership of a process does not necessary imply an effective cooperation. Examples of integrating relations are vertical integration (Webster, 1992), acquisitions (Ellram, 1991), joint venture (Ellram, 1991), and complete ownership (Bengtsson *et al.*, 1998, p.75) or mergers (MacBeth and Ferguson, 1994).

Some of the characteristics of collaboration are common with those of transaction and integration. For instance, it is assumed at all level of interaction that products and/or services are exchanged. Characteristics such as longer time frame or mutually shared goals are common between collaboration and integration but distinguish collaboration from transaction.

Another characteristics of higher levels of interaction, i.e. collaboration or integration, is the sharing of information between companies (Simatupang and Sridharan, 2005). The

[3] There are of course exceptions. Huge products, such as bridges and ships, can be delivered in a single product transaction, and requires a high level of interaction with suppliers and customers.

importance of information sharing is emphasized by Forrester (1958) and confirmed by Lee *et al.* (1997) through proving the spreading of the negative Forrester-effect or Bullwhip-effect, caused by information distortion, through a supply chain.

Each dyadic relation constitutes several business processes and the different processes can have different levels of interaction within the same relation. For example, in the dyadic relation between two actors, the information exchange process can be integrated, the order fulfillment process collaborative and the product development process transactional.

To facilitate the creation and maintenance of higher levels of interaction, certain enablers should however be present.

3.4.4 Enablers of higher levels of interaction

Mentzer (2001) defines enablers for interaction [collaboration] as common interests, openness, mutual help, clear expectations, leadership, cooperation, trust, benefit sharing, and technology. Worth noticing is that, without the other interaction enablers in place, advanced technology does not make any difference (Mentzer, 2001). It is also important to have a trusting relationship between the supply chain members, where each actor has mutual confidence in the other actors capabilities and actions (Sahay, 2003). Other enablers worth mentioning here are information sharing, decision synchronization, and incentive alignment (Simatupang and Sridharan, 2005) but also agreement, mutual gain, and common perception (Bititci *et al.*, 2004).

Information sharing could aid the decision makers' planning and control of operations. Decision synchronization comprises both the planning and the operational context. Synchronized planning decisions include selecting target markets, product assortments, customer service level, promotion, and forecast. Synchronized operation decisions incorporate shipping schedules and replenishment. Finally, incentive alignment refers to how and to what degree collaborative actors share costs, risks, and benefits (Simatupang and Sridharan, 2005).

To create successful supply chain interaction, each relation should be a conscious agreement between the two actors. The agreement could be defined in a contract or by mutual trust. A cooperative relationship should also be a win-win situation for both the concerned actors. Bititci *et al.* (2004) claim that both actors ought to have a common perception of the relation as a friendly collaboration, if not, one of the actors is using the other for its own purposes. Other authors, such as Cox (2001a), on the other hand, argue that a buyer-supplier relation must, at the most basic level, be inherently conflictual. This does not contradict that buyers and suppliers can cooperate, but rather that business relations must exist in a state of permanent tension since individuals and organizations primarily indulge in exchange relations in order to satisfy their desire for money.

In the next chapter, the factors that affect the appropriate level of interaction in different situations will be treated.

CHAPTER 4

FACTORS AFFECTING LEVEL OF INTERACTION

CHAPTER INTRODUCTION

In the previous chapter it was concluded that the interaction between two dyadic actors are affected by the actor's attitude towards each other, or the relation, and the supply chain context the relation exists in. This is all related to the arcs between the nodes in a supply chain network. In this chapter, the internal prerequisites within each actor (node) will be investigated. The factors affecting the appropriate level of interaction for manufacturing actors will also be analyzed.

Initially, a number of "classical" models and frameworks are presented. The models and frameworks that are included all acknowledge that the internal process or the supply chain and its relations should be affected by its content.

The aim of this compilation of previous research is to identify important categories that affect supply chain interaction and levels of interaction, but also to investigate if any of the existing frameworks is a suitable base for the interaction framework.

Next, each of the identified categories is investigated further to operationalize the categories into factors (decision aspects).

Finally, all of the categories and factors found in this research are compiled at the end of this chapter.

4.1 SUPPLY CHAIN INTERACTION FRAMEWORKS

An often referred to model of supply chain priorities was developed by Fisher (1997), see Figure 4.1. He emphasized the impact of product characteristics on the supply chain priorities and identified two different types of supply chains, the physically efficient chain, and the market responsive chain. These types of chains are appropriate for distributing products with certain characteristics and the level of interaction within the different types of chains has different priorities.

The physically efficient chain supplies a predictable demand efficiently at the lowest possible cost. Cost cutting is achieved by close co-ordination or competitive negotiations with the suppliers. The market responsive chain responds quickly to unpredictable demand in order to

minimize stock-outs, markdowns, and obsolete inventory. The suppliers in this type of chain are evaluated on speed, flexibility, and quality. See also Table 4.1 and Table 4.2.

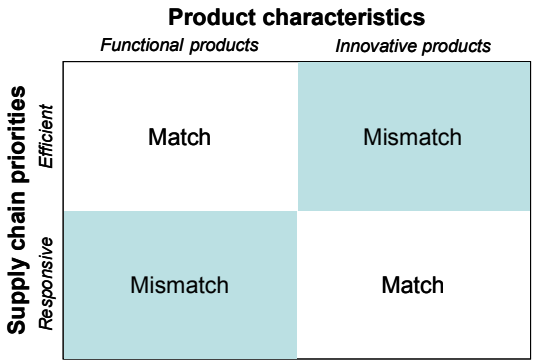

Figure 4.1 Matching supply chains with products (Fisher, 1997, p. 109)

The model by Fisher has gained a lot of, at least academic, interest with over 120 citations according to Science Citations Index (2007). This is probably due to its simplicity. However, simplicity is not always beneficial. This model merely gives the actor a hint of the appropriate what kind of supply chain. No explicit examples of appropriate level of interaction, types, or time frames for the supply chain interaction are given.

The first step, according to Fisher, in developing an effective supply chain strategy is to consider the demand pattern for the products to determine if they are either functional or innovative, see Table 4.1.

Table 4.1 Functional versus innovative products: differences in demand (Fisher, 1997, p. 107)

	Functional	Innovative
Aspects of demand	Predictable demand	Unpredictable demand
Product life-cycle	> 2 years	3 months - 1 year
Contribution margin	5% - 20%	20% - 60%
Product variety	10 - 20 variants/category	Millions of variants/category
Average margin of error in the forecast at the time production is committed	10%	40% - 100%
Average stock out rate	1% - 2%	10% - 40%
Average forces end-of-season markdown as percentage of full price	0%	10% - 25%
Lead time required for make-to-order products	6 months - 1 year	1 day - 2 weeks

The content of this table can be challenged. Does the contribution margin solely depend on how predictable the demand is and not on the number and strength of the competitors? How

does the possibility of using mass-customization affect Fisher's conclusions about product variety?

The next step is to determine whether the supply chain used to replenish these products is physically efficient or responsive to the market, see Table 4.2.

Table 4.2 Physically efficient versus market-responsive supply chains (Fisher, 1997, p. 108)

	Physically efficient process	Market-responsive process
Primary purpose	Supply predictable demand efficiently at the lowest possible cost	Respond quickly to unpredictable demand in order to minimize stock-outs, forced markdowns, and obsolete inventory
Manufacturing focus	Maintain high average utilization rate	Deploy excess buffer capacity
Inventory strategy	Generate high turns and minimize inventory throughout the chain	Deploy significant buffer stocks of parts or finished goods
Lead time focus	Shorten lead time as long as it doesn't increase cost	Invest aggressively in ways to reduce lead time
Approach to choosing suppliers	Select primarily for cost and quality	Select primarily for speed, flexibility, and quality
Product design strategy	Maximize performance and minimize cost	Use modular design in order to postpone product differentiation for as long as possible

The manufacturing focus, and inventory strategy presented in the table above appears to be internal aspects, but is referred to as a supply chain aspect. Since Fisher does not state on what system level he views the supply chain it is difficult to determine if they are internal or external aspects.

The next statement to investigate is that buffering stock makes a supply chain responsive. The product-mix variety, the product life-cycle length, and the product life-cycle phase may also affect the responsiveness. Another thing is the statement that indicates that the competitive priorities cost, quality, speed, and flexibility are mutually exclusive. This has been challenged by several researchers (e.g. Ferdows and De Meyer, 1990; Womack *et al.*, 1990; Hayes and Pisano, 1996).

Fishers model have been criticized before, for example by Lamming *et al.* (2000). They state that "Fisher provides a few examples of functional and innovative products but does not specifically define or measure his categories or provide theoretical underpinning" (Lamming *et al.*, 2000, p. 679).

Lamming *et al.* (2000) have, with Fisher's ideas as a starting point, developed a model for classification of supply chain networks (system level 4). They have also used the product characteristics as a differentiator but extended the aspects of the product to include, not only innovativeness but also uniqueness and complexity. They further argue, that since companies want to protect their unique resources in order to gain competitive advantage it is expected that they exercise carefulness in sharing these resources with other parties. Therefore they make the distinction between supply chain networks of innovative-unique products and supply chain networks of functional products, see Table 4.3. This will also affect the nature of

information and knowledge sharing and thereby the level of interaction in the supply chain network.

Table 4.3 Classification of supply networks (Lamming *et al.*, 2000, p. 687)

Characteristics	Supply networks of innovative and unique products	Supply networks of functional products
Higher complexity	*Competitive priority:* speed and flexibility, innovation, quality supremacy *Sharing of resources and information:* large amounts of non-strategic information enabled by IT - problematic when involving sensitive information and knowledge	*Competitive priority:* cost reduction, service, quality sustainability *Sharing of resources and information:* large amounts of non-strategic information enabled by IT - generally unproblematic: may include cost breakdowns and strategic knowledge
Lower complexity	*Competitive priority:* speed and flexibility, innovation, quality supremacy *Sharing of resources and information:* problematic exchange of sensitive information and knowledge - IT less critical	*Competitive priority:* cost (by high volume production), service *Sharing of resources and information:* generally unproblematic - may include cost and strategic knowledge - IT less critical

The model by Lamming *et al.* is more detailed than Fisher's model but it does not offer any better or more complete explanation to what product complexity is, what it depends on, or how it affects the supply chain relation. Neither is the design process to achieve a supply network for innovative and unique products or for functional products clarified.

Kraljic presented in 1983 a model where the supplier market and the product characteristics affect a company's[4] purchasing strategy, see Figure 4.2. Hence, not only the product per se is regarded but also its strategic role. The supply chain context that will affect the supply chain relations is also regarded, at least in the upstream supply chain (this model only focuses on the supplier market). For example, when the number of available suppliers decreases, a previous non-critical item might require additional purchasing attention in order to secure supply.

[4] Kraljic uses the term 'company', which may include several actors according to the definition used in this thesis. Kraljic's original wording is used in order to not intertwine the original meaning of the article.

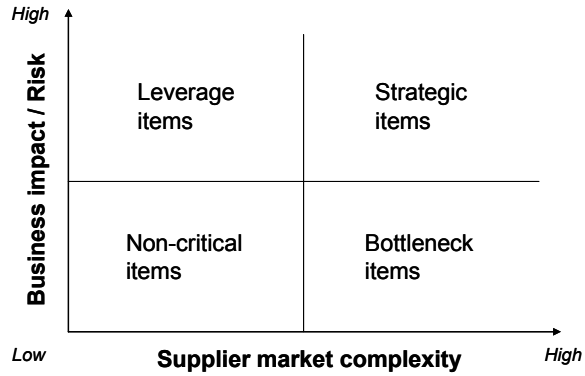

Figure 4.2 The Kraljic matrix, as illustrated in Beer (2006), originating from Kraljic (1983)

This model did not originate as an academic theory, but was instead developed as a practical method for purchasing. In academia the article was first published in 1977 in a German purchasing magazine (Beer, 2006, p. 33). The model has been criticized for being transaction-oriented, but the aim with this matrix is to identify which suppliers to develop long-term relationships with, and which suppliers to keep at arms-length (Beer, 2006, p. 29).

A company's need for supply strategy depends on two factors, according to Kraljic:

1. The business impact or risk in terms of
   - Value added by product line
   - Percentage of raw materials in total costs
   - Impact on profitability
2. The supplier market complexity in terms of
   - Supply scarcity
   - Pace of technology
   - Pace of material substitution
   - Entry barriers
   - Logistics cost or complexity
   - Monopoly or oligopoly conditions

The often referred to matrix (Kraljic's purchasing matrix, Figure 4.2) shows the four alternative results when assessing the current situation in terms of these two variables. When a supply strategy is selected, the purchasing process has to be aligned in order to shape the anticipated strategy. The shaping process, according to Kraljic, constitutes of four phases. This part of the article from 1983 is often omitted when Kraljic's purchasing matrix is presented but is presented here to gain a better understanding of the content of the model. The phases are as follows:

Phase 1: Classification of purchased materials and components in terms of profit impact and supply risk.

Profit impact of a given supply item is defined as:

- Volume purchased
- Percentage of total purchase cost
- Impact on product quality
- Impact on business growth

Supply risk is assessed in terms of:

- Availability
- Number of suppliers
- Competitive demand
- Make-or-buy opportunities
- Storage risks
- Substitution possibilities

Using these two criteria, profit impact and supply risk, on all purchased items, helps the company to sort the items into one of four categories:

1. Strategic
2. Bottleneck
3. Leverage
4. Non-critical

Each of these categories requires a distinctive supply strategy and furthermore, changes in supply or demand patterns can change the strategic category of a material. In the following phases, the focus will be on finding the right supplier for the strategic items. Next, the company has to balance its own strength against the power of the suppliers.

Phase 2: Market analysis

In this phase, the company assesses the supply market and reviews availability of strategic materials in terms of quality and quantity. They also have to review the relative strength of existing suppliers. This is done by comparing its own strength with the supplier strength regarding a number of criteria.

The list presented in Table 4.4 is an example since the evaluation criteria is dependent on the industry that is evaluated. In addition, the relative importance of different criteria might vary for different companies in the same industry.

Table 4.4 Market analysis evaluation criteria (Kraljic, 1983, p. 114)

Supplier strength	Company strength
Market size versus (vs.) supplier capacity	Purchasing volume vs. capacity of main units
Market growth vs. capacity growth	Demand growth vs. capacity growth
Capacity utilization or bottleneck risks	Capacity utilization of main units
Competitive structure	Market share vis-à-vis main competition
ROI[5] and/or ROC	Profitability of main end-products
Cost and price structure	Cost and price structure
Break-even stability	Cost of non-delivery
Uniqueness of product and technological stability	Own production capability or integration depth
Entry barrier (capital and know-how requirements)	Entry cost for new sources vs. cost for own production
Logistics situation	Logistic

Phase 3: Strategic positioning
The materials identified as strategic in phase 1 is positioned in the purchasing portfolio matrix. The matrix plots the company's buying strength against supply market strength, see Figure 4.3. The matrix is used to identify areas of opportunity or vulnerability. The matrix contains three basic risk categories; Exploit, Balance, and Diversify, henceforth referred to as the three strategic thrusts.

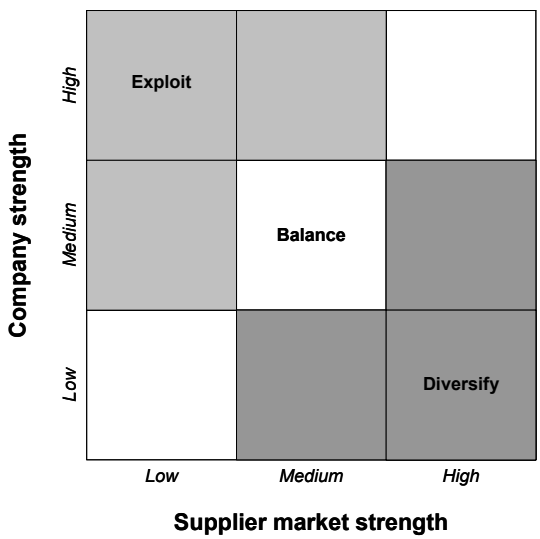

Figure 4.3 The purchasing portfolio matrix (Kraljic, 1983)

The company will have different roles depending on different purchased items and different suppliers.

[5] ROI = Return on Investment, ROC = Return on Capital

Phase 4: Action plans

The three strategic thrusts have different implications on the purchasing strategy in terms of:

- Volume
- Price
- Contractual coverage
- New suppliers
- Inventory policy
- Own production
- Material substitution
- Value engineering
- Logistics

In this phase, a range of supply scenarios are explored in order to secure long-term supply and for exploiting short-term opportunities. This results in a set of strategies for the critical purchasing materials where the timing and criteria for future purchasing action is defined.

This model states clearly that the relations with the suppliers should be affected by the product that is concerned. However, the product characteristics are only evaluated regarding the strategic importance for the company and not regarding any deeper dimension such as the technical specifications. The focus is not on the supplier relation, but instead on how to identify suppliers with less power that can be forced into price bargains. The only thing that could be interpreted as concerning supplier relations is one of the company strength evaluation criteria in phase 2 – integration depth. But since this criteria is not further explained, it is stated to be self-explanatory (Kraljic, 1983, p. 113) it is not enough for this thesis.

While Kraljic's purchasing matrix is a tool to identify where the purchasing power is best needed regarding the supplier market, product profiling is a tool to gain comprehensive understanding of how well the alternative production processes can support the current market requirements an organization is facing. A profile analysis is a managerial tool. It helps to evaluate the fit between a company's order winning criteria (see section 4.5.7) and its manufacturing ability to support these criteria.

The profile analysis also acknowledges that this decision is influenced (affected) by a number of aspects within four categories.

The product profiling presented by Hill (1995; 2000) can be undertaken at company level or process level. The procedure used in product profiling is as follows (Hill, 2000):

1. Select relevant aspects of products and markets.
   - The criteria selected must relate to the issues at hand and reflect the strategic dimensions of relevant markets. Other aspects than those presented in Figure 4.4 might hence be selected.
   - The number of criteria must be kept small enough to allow the overall picture to show through.
2. Display the trade-offs of process choice that is typical for each criterion (for example 'customer order size' usually ranges from small to large).

3. Profile the products, product groups, customers, or companies [entities] involved, i.e. position the selected entities on each criteria. Since this is a comparative technique, the relationship between different entities should be shown. For example, different products or different customers can be compared to each other.
4. The resulting profile illustrates the degree of consistency between the characteristics of the market and the relative position of the company's manufacturing.

The manufacturing processes used in Hill's framework originates from Hayes and Wheelwright (1979).

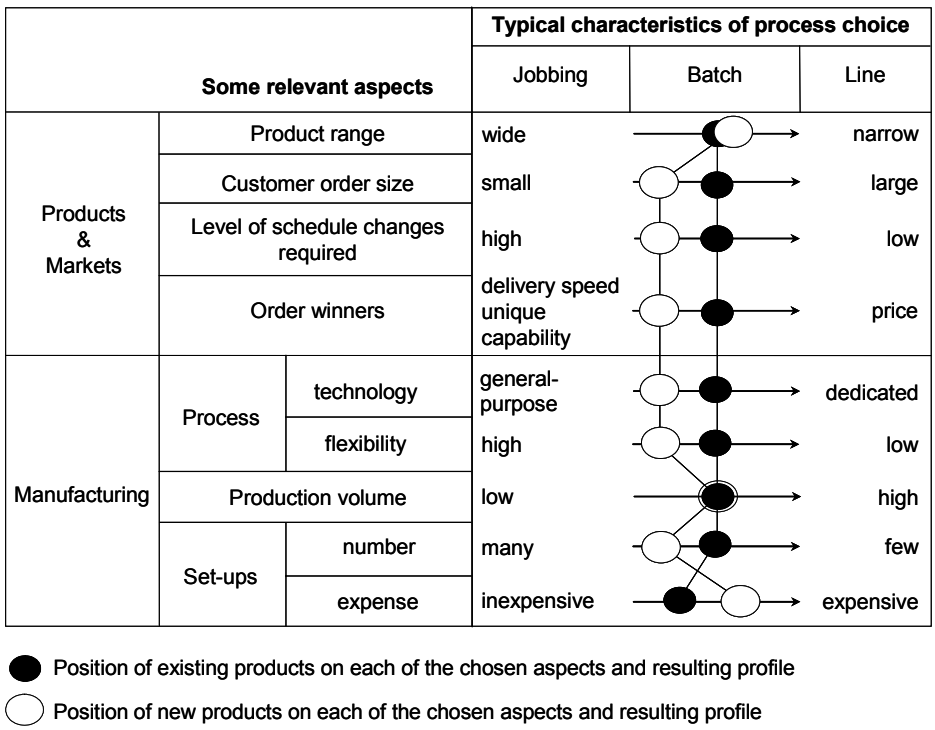

Figure 4.4 Product profiling (Hill, 2000, p. 153)

The main purpose of the profile analysis is to assist managers in the process of selecting the most appropriate process and also to identify how the alignment between the determinants (factors) and the process choice can be improved (Pagh and Cooper, 1998). The framework is thus both descriptive and normative (Pagh and Cooper, 1998). However, the most appropriate strategy does not have to have every "facet" correctly in place; a company can live with mismatches if it is aware of its position (Hill, 2000).

This framework is more nuanced than the previously presented models by Fisher, Lamming *et al.*, and Kraljic. Firstly, the scale is more continuous even though the selection of process choice usually is one of the three; jobbing, batch, or line, and mismatches are permitted. There are at least two more available process choices in literature; project and continuous flow processing, but these are only appropriate in very specific situations and circumstances and are

hence seldom regarded as available alternatives for discrete manufacturing (Hayes and Wheelwright, 1979). This framework is suited as a managerial decision support. It does not only state that the present situation represents a mismatch (as could be the case with Fishers model) but instead it shows in a more detailed way where the mismatch occurs. Hill's framework provides a more complete picture than the previously presented matrices, but it is not sufficient to fulfill the aim with this research since it does not include supply chain relations.

What about the model for developing the manufacturing strategy that was presented by Miltenburg in 1995? This model, depicted in Figure 4.5, is definitely more complete than the models presented previously, but it is at the same time much more complex.

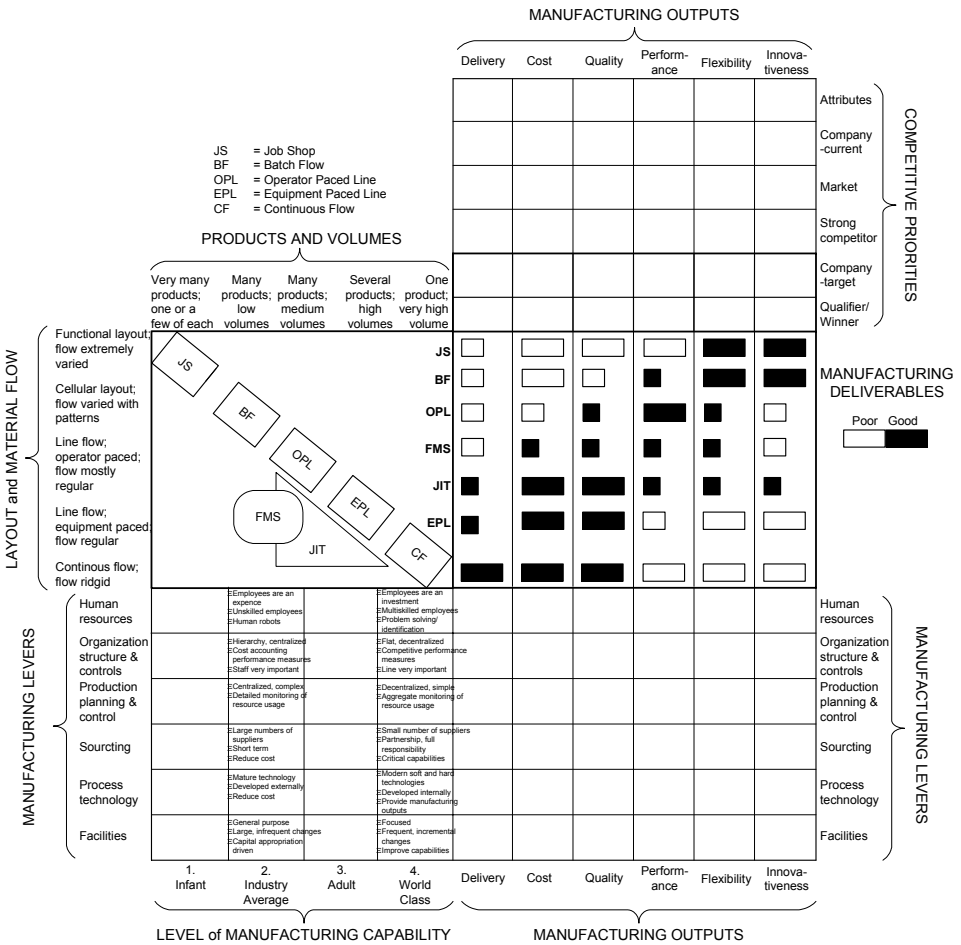

Figure 4.5 The manufacturing strategy worksheet (Miltenburg, 1995, p. 4; 2005, p. 4)

Does this acknowledge that the supply chain and its relations should be affected by its content? Just barely, the only element that treats the surrounding supply chain is 'sourcing'

under manufacturing levers. The Miltenburg framework instead focuses on how the product should affect the actor's internal processes, or strategy. It handles the product characteristics in terms of product range and product volumes in a product/process-matrix that originates from Hayes and Wheelwright (1979). Miltenburg then links the layout and material flow (production processes) to the manufacturing outputs (competitive priorities) and states if, and to what degree, each manufacturing output is supported by each production system. The framework is finally extended to cover the manufacturing levers: human resources, organization structure and controls, sourcing, production planning and control, process technology, and facilities.

The manufacturing lever 'sourcing' is defined as the lever that focuses on relationships with suppliers and distributors. Decisions within sourcing includes, according to Miltenburg:

- Number of suppliers and their capabilities
- Adversarial or partnership relationship with suppliers
- [The degree of] responsibility given to suppliers for design, cost, and quality
- Produce a part in-house or outsource

This touches the supply chain relationship area but it does not give the company any guidance of *how* the relationships with suppliers or distributors should be designed.

Cravens *et al.* (1996) have developed a stereotypical model of network organizational forms where the relationships in the network are central, see Figure 4.6. The different network forms are based on two dimensions of classification: the volatility of environmental change and the type of relationships among the network members. The volatility reflects characteristics such as speed, degree, unpredictability, and uncertainty of radical changes in the environment. The types of relationships among members in the network range from collaborative to transactional.

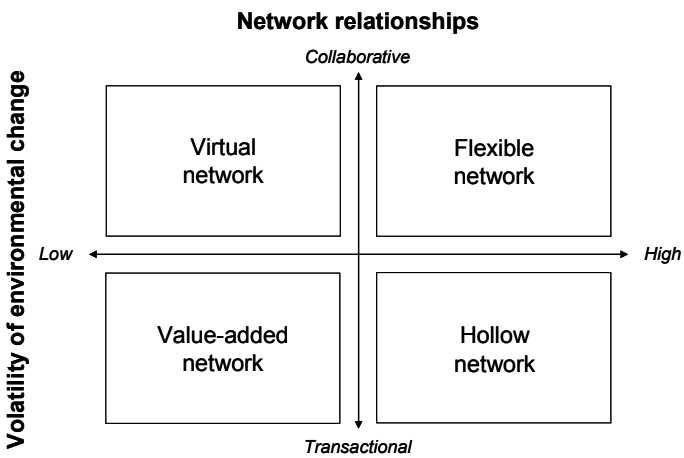

Figure 4.6 Classification of network organizations (Cravens *et al.*, 1996)

The characteristics that determine the alternative network forms are: the environmental fluctuations, the relationships between network coordinator and other network members, the

relationship with end-user, the market structure, the technological complexity, the core competency of the coordinating organization, and the network members' core competency.

The four network forms are as follows:

- Hollow network – A transaction based organization associated with a highly volatile environment. The core organization depends heavily on other organizations to satisfy customer needs. It is appropriate in highly segmented markets where customer needs are differentiated. This network provides the flexibility to shift to new opportunities and new sources of supply.
- Flexible network – Associated with high environmental volatility and long-term intra-organizational collaboration. The network coordinator identifies customer needs, designs products, and establishes sources of supply. This type is likely under conditions of asset specificity. The market environment involves fast response times, high added value, and high risk.
- Value-added network - Associated with markets where preferences are diffused and segments hard to define but the volatility is relatively low. Most relationships tend to be transactional. This fits markets with no complex technologies or customized products. Members of the network perform tasks at a low cost.
- Virtual network - A limited reformation of the traditional organization where the focal firm seeks to establish collaborative relationships with other firms. The network is likely to possess core competency. It also has a long-term orientation with the goal of meeting the sometime complex needs of the segmented market. The members of the network provide a buffer for the focal firm against risks and uncertainties.

In this classification the relationships in the supply chain network is taken into consideration. The network relationship dimension that ranges from transactional to collaborative can be translated into ranging from a low level to a high level of interaction. The stereotypical model proposes no appropriate types of interaction within these levels. Even though the product characteristics are not explicitly mapped in this model, the order winners and order qualifiers on the market can be interpreted in the explanations of the network forms.

4.1.1 Summary of described frameworks

Fisher's matrix evaluates if the existing supply chain is right for a specific product, based on the product characteristics and the supply chain priorities. Since Fisher does not state on what system level he views the supply chain, it is not clear if the model is applicable for the supply chain level or only for the internal processes. Fisher neither states what kind of supply chain relation that is needed to achieve either of the supply chain priorities (responsive or functional), nor is the presented product characteristics detailed enough to treat disperse product types.

The model offered by Lamming *et al.* is more detailed than Fisher's model and they expand the product characteristics concept to include also complexity. However, their model does not offer any more complete explanation of; what product complexity is, what it depends on, or how it affects the supply chain relation. Neither is the design process to achieve the supply network for innovative and unique products or for functional products, clarified.

Kraljic's purchasing model states clearly that relations with the suppliers should be affected by the product that is concerned. However, the product characteristics are only evaluated at the level of the strategic importance for the company and not regarding any deeper dimension, such as technical specifications. The focus is not on the supplier relation, but instead on the

total supplier market complexity and on how to identify the suppliers with less power that hence can be forced into price bargains.

The framework developed by Hill, where the fit between manufacturing capabilities and product characteristics/market requirements can be evaluated, is more nuanced than the previously presented models. The scale is for example continuous and mismatches are permitted. This framework is hence better suited as a managerial decision support, but it does not fulfill the aim with this research since it does not include supply chain relations.

Miltenburg's model for developing a manufacturing strategy is thorough and touches the supply chain relationship area but it does not give the company any guidance of *how* the relationships with suppliers or distributors should be designed. Miltenburg acknowledge that the product characteristics (products and volumes) the market requirements (manufacturing outputs), the supply chain context (competitive analysis), the internal processes (manufacturing levers, layout/material flow, and manufacturing outputs), and the supply chain relations (manufacturing levers – sourcing) are interconnected. He also acknowledges that these categories are important to consider when developing a manufacturing strategy.

In the classification by Cravens *et al.,* the relationships in the supply chain network are taken into consideration together with the environmental volatility. The product characteristics are not explicitly mapped in this model, but product order winners and order qualifiers can be interpreted in the explanations of the network forms.

The categories, that are regarded as affecting a companies prerequisites and hence its relations, that were considered in the models and frameworks previously, are compiled in Table 4.5.

Table 4.5 Summary of categories regarded in previous research

Category Author(s)	Product characteristics	Supply chain context	Internal process	Market requirements	Supply chain relations
Fisher (1997)	X	X			
Lamming *et al.* (2000)	X	X			
Kraljic (1983)	X	X	X		
Miltenburg (2005)	X	X	X	X	
Hill (2000)	X		X	X	
Cravens *et al.* (1996)	(X)		(X)	X	X

As can be seen, none of the existing models treats all of the identified categories. The five identified categories listed below will henceforth be further investigated.

- Product characteristics – the unit that is being exchanged within the relation.
- Supply chain context – the surroundings a relation exists in.
- Internal process – within a node.
- Market requirements – the manufactured product have to compete on the market.
- Supply chain relations – the arch/link between two nodes.

The aim of the forthcoming sections is to identify factors within each category that will affect the appropriate level of interaction with suppliers and customers.

4.2 PRODUCT CHARACTERISTICS

The product characteristics desired by a customer have to be met by the characteristics of the product offered by a company. The product characteristics can be described from a customer's point-of-view or from production point-of-view. The product characteristics from a customer's point-of-view can be described as the rate of adoption [on the market] (Kotler *et al.*, 2001, p. 225) Five characteristics that are especially important in influencing a products rate of adoption are according to Kotler *et al.* (2001):

- Relative advantage – if the product appears superior to existing products.
- Compatibility – if the product fits the values and experiences of potential customers.
- Complexity – if the product is difficult to understand and use.
- Divisibility – if the product can be tried prior to purchase.
- Communicability – if the experience of the product can be observed or described to others.

Other customer-view characteristics can be: initial and ownership costs, risk and uncertainty, and social approval (Kotler *et al.*, 2001). The physical characteristics of a product are in customer terms named 'attributes'. The product attributes that are important for the customer are; quality, features, and style and design (Kotler *et al.*, 2001, p. 466).

Apart from the characteristics that are of importance for the customer, a product possesses additional characteristics such as 'number of components' (Garwood, 1995), 'commonality of the components with other products of the company' (Fernández-Rañada *et al.*, 2000). Also type and sequence of manufacturing processes required to manufacture the product can be seen as product characteristics (Vollmann *et al.*, 2005).

Lakemond has compiled a number of different product characteristic factors from different authors in her dissertation (Lakemond, 2001). These are, for example:

- Number of product functions (Griffin, 1997, p. 29).
- Number of components (Hayes *et al.*, 1988).
- Degree of interdependence between product and process (Tatikonda and Rosenthal, 2000).
- Innovation level (Tatikonda and Rosenthal, 2000).
- Novelty of product (Tatikonda and Rosenthal, 2000).
- Linkage between sub-systems [if the way a products' components are linked together changes] (Henderson and Clark, 1990).
- Development risk in forms of importance, newness, and complexity of development (Wynstra and ten Pierick, 2000).

Both the product being manufactured and the process used to manufacture can have different levels of complexity and criticality (Hayes *et al.*, 1988). The impact of the product complexity on the supply chain or supply network was emphasized by Fisher (1997) even though the content of complexity was not fully covered.

When extending the product complexity to cover also uniqueness and strategic importance, Lamming *et al.* (2000) approached product criticality. Criticality could also imply how important a specific component is for a certain product and will thereby affect the required

delivery precision offered by the collaborators. Product uniqueness refers to non-substitutability and is a factor that is difficult to operationalize since it is so closely intertwined with process technology novelty (Lamming *et al.*, 2000; Lakemond, 2001).

4.2.1 Product life-cycle

The life-cycle stage (or phase) the product currently is at, has been identified as affecting appropriate production process (Hayes and Wheelwright, 1979; Hill, 2000, p. 132), marketing (Hayes and Wheelwright, 1984, p. 202), manufacturing focus (Hill, 2000, p. 173), order winners and order qualifiers (Hill, 2000, p. 55), and appropriate postponement and speculation strategy (Pagh and Cooper, 1998). Different life-cycle stages are illustrated in Figure 4.7.

The stage of the product life-cycle will also affect the product's design stability, the product development cycle length, the frequency of engineering change orders and the commonality of components (Hayes and Wheelwright, 1984, p. 203). According to Miltenburg, also product design, sales and production volume, and profit per unit of product may change at each stage of the product life-cycle (Miltenburg, 1995, p. 222). It is therefore assumed that the different life-cycle phases will affect the level of interaction in different ways.

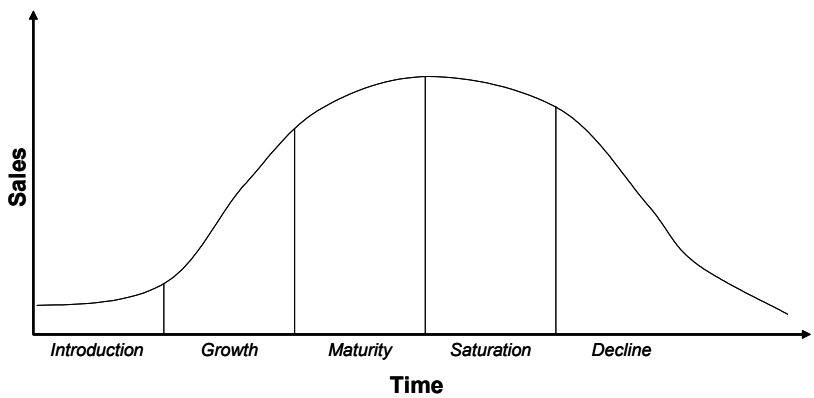

Figure 4.7 Product life-cycle stages (Hill, 2000, p. 55)

Pagh and Cooper (1998, p. 22) state that consensus exists within manufacturing, marketing, and logistics literature on dividing the life-cycle for a product into a series of four distinguishable stages (introduction, growth, maturation, and decline). However, in the literature review, the stages in the product life-cycle differs between different authors, and sometimes also within the same publication, see a comparison in Table 4.6.

Table 4.6 Comparison of different product life-cycle stages

Pagh and Cooper (1998) Hill (2000, p.173)	Hill (2000, p. 55)	Hayes and Wheelwright (1984, p. 202)	Miltenburg (1995, p. 222) Miltenburg (2005, p. 301)
Introduction	Introduction	Start-up	Development
Growth	Growth	Rapid growth	Growth
			Shakeout
Maturity	Maturity	Maturation	Maturity
	Saturation	Commodity	Saturation
Decline	Decline	Decline	Decline

4.3 SUPPLY CHAIN CONTEXT

Even though it was concluded earlier, in section 3.3.4, that all interactions are constituted of dyadic relations, the context in which the actors interact will affect how they work together (Walters and Rainbird, 2007). Each actor has to be aware of what consequences a decision may have on its collaborators (Sahay, 2003). Hence, it is of tremendous importance if the context is constituted of a single actor, a chain of companies, or a network. This is the area most supply chain articles fail to elucidate. For example, the article by Oliver and Webber (1982) is often referred to as the first supply chain article, even though it only treats the integration of internal business functions.

4.4 INTERNAL PROCESS

The internal prerequisites for an actor will affect the means they have to interact with suppliers and customers. The internal prerequisites depend on the internal organization, process, technology, capability and capacity of resources, employee knowledge etc.

Both the product being manufactured and the process used to manufacture can have different levels of complexity and criticality. The process complexity refers to the difficulty in performing the operations due to inter-linkages with other processes (Sahay, 2003). Process criticality, then, refers to the importance of the particular process to the overall supply chain (Sahay, 2003).

An increased need for control in the supply chain requires a higher level of interaction or an integrating relationship (Bengtsson *et al.*, 1998, pp. 75-77). The need for flexibility, on the other hand, is supported by a lower level of interaction or a transactional relation since these relations are more dynamic and more easily changed or terminated than a stable integrated relation (Bengtsson *et al.*, 1998, pp. 75-77).

Given the effort involved in creating and sustaining collaborative or integrating relations, an actor has to focus on the relations it considers most important in the long run (Corbett *et al.*, 1999). The importance of a relation is in its turn influenced by a number of aspects, for example the power of the buyer or supplier, the complexity and criticality of the product, and the time frame of the relation.

4.5 MARKET REQUIREMENTS

Different market requirements can apply to the same product, depending on how the company chooses to compete on the market. There is thus a need to first identify relevant market requirements and then to clarify the impact these market requirements should have on the level of interaction.

Consider for example a fairly simple product that most people have experience of – milk. This example is used as an illustrating example, even though milk is a processed product and not a manufactured product. The product characteristics for milk are easily agreed upon; it is clearly fluid and perishable. The market requirements on the other hand might differ greatly, depending on which market it is intended for.

If the purpose of buying milk is to get some milk in your coffee at work, the relevant requirements may be that the milk should be available in an appropriate volume at a store close to the office (shelf availability). The price per liter could then be of less concern.

If the purpose of buying milk instead is to provide all the local schools with lunch milk, other market requirements will certainly apply. The milk should then be delivered at the right time to the right school in the right quantity and the quality of the milk must fulfill certain requirements. The available suppliers will also compete with pricing. The market requirements could be maintained quality, delivery precision, and price. This type of diverging market requirements can be found for most products that have more than one field of application or compete in more than one market.

An analogy can here be made to the statement by Berry and Hill (1992) that companies need to make different choices of process depending on market requirements; companies also have to make different choices of level of interaction depending on market requirements.

4.5.1 Competitive priorities

Several authors have identified competitive priorities as a set of goals for manufacturing which are used to align the business strategy and market requirements with the manufacturing task (e.g. Leong *et al.*, 1990; Rudberg, 2004). To identify the relevant market requirements, market aspects such as target segment, product life-cycle phase, competition, and rules and regulations must be taken into consideration. These market aspects will affect which market requirements apply and consequently which competitive priorities are relevant.

The competitive priorities were initially identified as cost, quality, flexibility, and delivery (Skinner, 1969; Wheelwright, 1978; Fine and Hax, 1985). In a literature review Leong *et al.* (1990) identified a consensus on a set of five competitive priorities where innovativeness also was included. These five competitive priorities have later been empirically supported by Ward *et al.* (1998). Miltenburg (1995, p.15) further includes a sixth manufacturing output – Performance. In Table 4.7 different competitive priorities are compiled, and authors supporting one ore several of these priorities are stated.

Table 4.7 Compilation of competitive priorities and authors

Autor(s)	Quality	Delivery	Cost	Flexibility	Other
Miltenburg (1995, p. 15)	x	x	x	X	Innovativeness Performance
Wheelwright (1978)	x	x	x	X	
Hayes and Wheelwright (1984)					
Skinner (1969)	x	x	x	X	
Fine and Hax (1985)	x	x	x	X	
Harland (1997)	x	x	Price		Service/Range
Garvin (1987)	x				
Gerwin (1987)				X	
Browne (1984)				X	
Slack (1983; 1988)				X	
Ward *et al.* (1998)					Innovativeness
Leong *et al.* (1990)					Innovativeness

Each competitive priority can be broken down into a number of dimensions. Some of the dimensions for the five most common competitive priorities are presented in Figure 4.8.

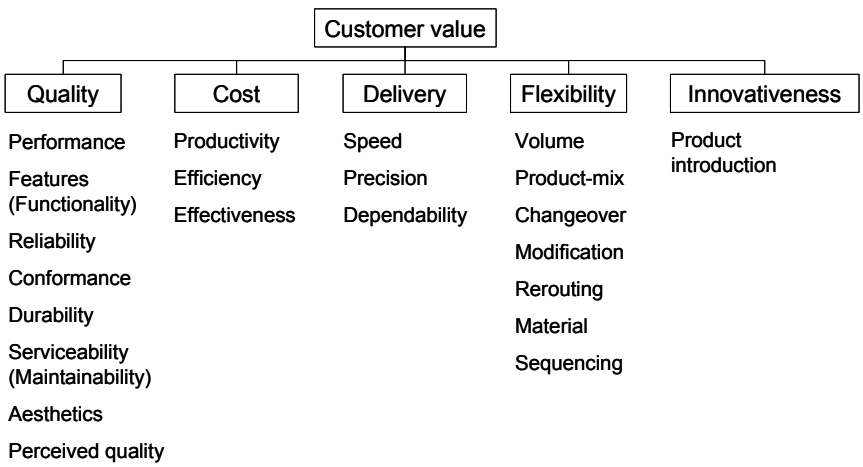

Figure 4.8 Dimensions of competitive priorities

These market requirements, or competitive priorities, must be taken into consideration when selecting an appropriate level of interaction with each supplier or distributor for a product. Otherwise, the competitive advantages created by the internal processes might be diminished.

The internal production process will henceforth be viewed as a black-box, where the right quantity is assumed to be produced at the right time with the right quality and where only the input and output i.e. supply and distribution can be influenced. Something that must be noted is that the market requirements of interest here might be different from those that apply when manufacturing the product. For example, the market requirements that can be supported by supply are those, which can be affected before the products are manufactured.

Likewise, the market requirements that can be affected by distributors are those that can be influenced when the end-product is finished.

4.5.2 Quality

The competitive priority *quality* refers to product and service quality. Quality can, according to Garvin (1987), be viewed as consisting of eight dimensions: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality.

A supplier can influence the first seven quality dimensions. Perceived quality is primarily a result of marketing (Corbett and Van Wassenhove, 1993). Correct product quality will support all the competitive priorities: *quality, cost, and delivery precision/speed* since quality decreases scrap and the need for returns.

A distributor's main focus should be to maintain the product quality delivered from the manufacturing actor. A distributor can influence and enhance the perceived quality and the service.

4.5.3 Cost

The competitive priority *cost* refers to both the cost of the product (how much the manufacturing actor has to pay for raw materials and components) and the pricing of the product (how much the customer will have to pay for the end-product).

The supplier can primarily influence the product costs and can thereby indirectly influence the pricing.

A distributor can affect the product image and the target segment, and thereby the price that can be charged, by for example either making the product available everywhere or making sure that the product is rare. A distributor can, as was noted previously, also influence the perceived quality and the perceived service. This in turn will influence what level of pricing the customer accepts.

4.5.4 Delivery performance

The competitive priority *delivery performance* can be viewed as comprising delivery dependability (reliability), delivery precision, and delivery speed (e.g. Leong *et al.*, 1990; Miltenburg, 1995, p.16).

To be able to provide the customer with the finished products at the right time without carrying excess inventory, the suppliers also have to deliver with precision.

The distributor needs to be able to identify what the customer demands and to realize the difference between delivery speed (deliver as fast as possible) and delivery precision (deliver when agreed).

4.5.5 Flexibility

The competitive priority *flexibility* is usually divided into product mix and volume flexibility (Leong *et al.*, 1990). Browne *et al.* (1984) presented eight dimensions of flexibility, in addition to volume and product mix, they included machine, process, routing, expansion, operation, and production flexibility. Gerwin (1987) also includes five additional flexibility categories: changeover, modification, rerouting, material, and sequencing flexibility. Slack (1988) defines two elements of flexibility: resource and system flexibility and two dimensions of flexibility; range and response flexibility. The different flexibility dimensions are compiled in Table 4.8.

Table 4.8 Comparison of different author's definition of flexibility dimensions

Browne (1984)	Gerwin (1987)	Slack (1988)
Machine	Changeover	Resource:
Process	Modification	- process
Product	Product mix	- labor
Routing	Rerouting	- infrastructure
Volume	Volume	System:
Expansion		-.product
Operation	Sequencing	- mix
Production		- volume
	Material	- delivery

Suppliers can improve the flexibility by offering capacity and/or material. The company has to make a 'make-or-buy' decision regarding how to source components and raw material. The decision is highly dependent on what the available suppliers offer.

Flexibility in time is a common demand on distributors. Will the products be shipped when ready or must the shipments be scheduled in advance? The distributor can enhance the flexibility perceived by the customer by for example cross-docking, coordinated transports, and re-routing. Postponement strategies, where the customization is carried out by the distributor, will also increase the flexibility (Pagh and Cooper, 1998).

4.5.6 Innovativeness

The competitive priority *innovativeness* refers to the introduction of new products and processes. This is hence closely related to the product development process.

An existing supplier can support innovativeness by presenting their own innovations or product enhancements to the company, by developing new products jointly with the company, by offering the component or production process that is needed, or by adapting their production to the new product invented by the company.

A distributor can increase the over all innovativeness by new, innovative ways of introducing the product on the market. Examples of this could be third-party logistics, new packaging solutions, and added value closer to market by postponement.

4.5.7 Order winners and order qualifiers

Order winners and order qualifiers refer to the criterion (usually within the competitive priorities) that are needed to win an order or to compete on the market at all respectively (Hill, 2000 p. 37). The order winning and qualifying criteria represent a way of describing a market in terms of required manufacturing capabilities (Berry and Hill, 1992; Rudberg, 2002). The order winners and order qualifiers evolve over time and different criteria applies at different stages of the product life-cycle (Corbett and Van Wassenhove, 1993). Before trying to adapt the level of interaction in the supply chain to support all the competitive priorities, an analysis of the market is needed to identify the order winners and order qualifiers that apply for that specific market and customer segment. (Hill, 1995; 2000)

Order qualifiers are the criteria that a product or a company has to meet in order to be considered as a possible supplier for customers. Within a certain product group, several companies will usually qualify as a supplier. Order winner is the criterion that determines which of the qualified suppliers/products a customer will choose. The criterion that will be the order qualifier or the order winner for a product is purely individual, something that is an

order winner for one customer could even be an order loosing sensitive criteria (an order qualifier that, when not fulfilled, will result in loosing this and possibly future orders) (Hill, 2000).

To be able to handle an almost infinite amount of individual customers, the customers are clustered together into segments with similar requirements. Companies have to be aware of which customer segments their products are aimed at, in order to align the resources to meet the product's order winner and order qualifiers. Everything within a company, from manufacturing process to marketing strategy should be adapted in order to support the order winners for the individual products. To aim the resources at the right target, companies must differentiate between immediate and end-customers. The process of defining a products order winner and order qualifiers is an iterative process since the criterions change over time and is different for different markets. (Hill, 2000)

Companies only have to be as good as its competitors when it comes to order qualifiers, but to win an order its order winner has to perform better than the competitors' do. The order winners and order qualifiers is usually constituted, with a production view, of the competitive priorities, even though other dimensions, such as brand name, design leadership, and environmental friendliness etc. could impact the decision, Hill (2000, pp. 76-78). There are other order winners that do not fall within manufacturing responsibility, such as after-sales service, technical liaison capability, and being the existing supplier (Hill, 2000, p. 36).

4.6 FACTORS AFFECTING SUPPLY CHAIN RELATIONS

There are several factors affecting the choice of interaction level. In some cases, two factors are correlating to each other, for example, a low level of trust might demand a highly specified contract. In this chapter, some of the factors, commonly known to affect the supply chain relations, are presented.

4.6.1 Trust

A successful relationship is characterized by mutual trust (Corbett *et al.*, 1999). Companies that trust each other generate profit, serve customers better, and are more adaptable (Corbett *et al.*, 1999). The nature of trust comprises dependability, faith, and fairness. However, trust is not only positive, it is also deceptive since companies tend to believe that associates they trust, trust them as well (Kumar, 1996; Sahay, 2003). Kumar (1996) further argues that successful relationships should be flexible, informal, and based on trust instead of based on long and detailed contracts. The conclusion is that trust is stronger than fear (contract).

4.6.2 Power

When designing a supply chain and cooperating with other companies, one has to consider the other actor's size, impact, and status. If the other actor is larger in size, has greater impact, and higher status, it will have more power in that relation. With greater power comes the ability to force a weaker actor to make decisions that are merely favorable for the powerful actor. The effect of power in supply chains has in fact been pointed out by several authors (Butaney and Lawrence, 1988; Cox, 2001a; b; Watson, 2001; Cox *et al.*, 2004).

4.6.3 Time frame

The time frame is the period of time when the relation should exist. This factor is traditionally viewed as an important differentiator since a long-term relation by definition is constituted of a high level of interaction. Today, with shorter time-to-market and shorter

product life-cycles, a short-term relation could be at least as collaborative or integrated as a long-term relation could. A long-term contract will, quite obviously, exist during an extended time frame. Long term commitment is, together with mutual trust, the characteristics of a successful relationship according to Corbett *et al*. (1999).

4.6.4 Maturity

Increased supply chain interaction maturity leads to reduced uncertainty, and improved business performance and is the best route to follow to achieve competitive advantage (Childerhouse *et al.*, 2003, p. 71). The characteristics of process maturity are predictability, capability, control, effectiveness, and efficiency (Childerhouse *et al.*, 2003, p. 72).

4.6.5 Frequency of interaction

Frequency refers to how often a transaction occurs (Ellram, 1991). According to a study of 160 companies, the success of customer-supplier relationship is dependent on the frequency of interaction between the partners (Sahay, 2003). There is no general rule to decide *how* frequently they should interact, but a portfolio matrix with four involvement zones was identified by the study. The involvement zones are strategic, outsourcing, in-house, and convenience involvement. Each zone proposes a different level of involvement in various activities. More transactions suggests greater routinization of interaction and is hence, according to Cooper *et al.* (1997a), an implication/incitement to form a closer relationship to make sure that transactions run smoothly.

4.7 CATEGORIZATION OF AFFECTING FACTORS

All factors presented previously, are here compiled and categorized, according to what category they belong to. For each factor, only one author is mentioned as a source. Further references can be found in the text previously in this chapter.

Table 4.9 Product characteristics

Product characteristics	Author(s)
Life-cycle phase	Pagh and Cooper (1998)
Life-cycle length	Fisher (1997)
Contribution margin	Fisher (1997)
Product variety	Fisher (1997)
Forecast error	Fisher (1997)
Stock-out rate	Fisher (1997)
End of season markdown	Fisher (1997)
Lead time	Fisher (1997)
Product type	Hill (2000)
Frequency of product changes required	Hill (2000)
Frequency of schedule changes required	Hill (2000)
Innovativeness	Lamming *et al.* (2000)
Novelty	Tatikonda and Rosenthal (2000)
Criticality	Lakemond (2001)
Uniqueness	Lamming *et al.* (2000)
Material substitution	Kraljic (1983)
Strategic importance	Kraljic (1983)
– Value added	Kraljic (1983)
– Percentage of raw material in total cost	Kraljic (1983)
– Impact on profitability	Kraljic (1983)
Complexity	Wynstra and ten Pierick (2000)
Number of components	Hayes *et al.* (1988)
Commonality of components	Fernández-Rañada *et al.* (2000)
Number of product functions	Griffin (1997)
Linkage between sub-systems	Henderson and Clark (1990)
Sequence of manufacturing	Vollmann *et al.* (2005)
Type of manufacturing	Vollmann *et al.* (2005
Product/process interdependence	Tatikonda and Rosenthal (2000)
Quality	Kotler *et al.* (2001)
Features	Kotler *et al.* (2001)
Style and design	Kotler *et al.* (2001)
Value profile	Pagh and Cooper (1998)
Monetary density	Pagh and Cooper (1998)
Share of service included	Pagh and Cooper (1998)

These factors will correspond to different levels of interaction, i.e. a high level of product complexity and strategic importance might imply that a high level of interaction is appropriate to ensure that the demand can be met.

In addition to these factors, throughput time and time-to-market ought to be product characteristic factors that affect the appropriate level of interaction.

Table 4.10 Supply chain context

Supply chain context	Author(s)
Entry barriers	Kraljic (1983)
Market share/number of customers	Kraljic (1983)
Profit margin	Fisher (1997)
Number of suppliers	Kraljic (1983)
Supplier capacity utilization (Risk for supply bottleneck)	Kraljic (1983)
Supplier product uniqueness	Kraljic (1983)
Raw material supply	Kraljic (1983)
Competitive demand	Kraljic (1983)
Pace of technology introduction	Kraljic (1983)
Logistics cost	Kraljic (1983)

Other supply chain context factors probably affect the appropriate level of interaction. Some can be derived with symmetry from the factors concerning suppliers – for example, number of suppliers, number of competitors, and number of customers, are all parts of the supply chain context. These probable supply chain context factors are compiled in Table 4.11.

Table 4.11 Further supply chain context factors

Supply chain context	Author(s)
Number of competitors	
Number of customers	
Rate of competitor introduction	
Market position	
Distance to supplier	
Distance to customers	
Rules and regulations	

Regarding market requirements, delivery speed is the only delivery-factor that has been found in the literature review, but delivery dependability and delivery precision are also market requirements that need to be supported by the supplier and that hence will affect the appropriate level of interaction. These factors are included in Table 4.12, without stating any specific author.

Table 4.12 Market requirements

Market requirements	Author(s)
Order winners	Hill (2000)
Quality	Skinner (1969)
Delivery speed	Skinner (1969)
Delivery dependability	
Delivery precision	
Delivery time (required)	Pagh and Cooper (1998)
Delivery frequency	Pagh and Cooper (1998)
Cost	Skinner (1969)
Flexibility	Skinner (1969)
Innovativeness	Leong *et al.* (1990)
Performance	Miltenburg (1995)
Customer order size	Hill (2000)
Level of demand	Fisher (1997)
Uncertainty of demand	Pagh and Cooper (1998)
Target segment	
Seasonality	
Trend	
Rate of new product introductions	Hill (2000)
Cost of non-delivery	Kraljic (1983)
Cost of non-quality	Kraljic (1983)

Internal factors that have not been found in the literature review, but that could affect the level of interaction are for example internal capacity, available capacity buffer, and employee capabilities. These factors are included in Table 4.13, without stating any specific author.

Table 4.13 Internal characteristics

Internal characteristics	Author(s)
Criticality	Sahay (2003)
Complexity	Sahay (2003)
Capacity	
Capacity buffer	
Process technology	Hill (2000)
Process flexibility	Hill (2000)
Level of capital investment	Hill (2000)
Economies of scale	Pagh and Cooper (1998)
Capabilities	Pagh and Cooper (1998)
Employee capabilities	
Production volume	Hill (2000)
Product-mix range	Hill (2000)
Ability to cope with product change	Hill (2000)
Ability to cope with schedule change	Hill (2000)
Setup – number of	Hill (2000)
Setup – expense	Hill (2000)
Key manufacturing task	Hill (2000)
Pace of technology substitution	Kraljic (1983)
Manufacturing focus	Fisher (1997)
Inventory strategy	Fisher (1997)
Lead time focus	Fisher (1997)
Supplier approach	Fisher (1997)
Product design	Fisher (1997)
Need for control	Bengtsson *et al.* (1998)
Need for flexibility	Bengtsson *et al.* (1998)

Table 4.14 Supply chain relations

Supply chain relations	Author(s)
Trust	Kumar (1996)
Power	Cox (2001b)
Bargain power	Kraljic (1983)
Time frame	Corbett *et al.* (1999)
Maturity	Childerhouse *et al.* (2003)
Frequency of interaction	Sahay (2003)

The factors identified in the theoretical study that affect the level of interaction have been compiled and categorized according to the category they belong to. This however does not suffice to fulfill the aim of this thesis. The factors have to be compiled and presented in a way, that primarily can serve as a basis for future empirical studies and subsequently be used as a decision support tool. One way to do this is proposed in the following chapter.

CHAPTER 5

INTERACTION FRAMEWORK DEVELOPMENT

CHAPTER INTRODUCTION

In this chapter, a theoretical interaction framework based on the results in the previous chapters, is presented. The aim of this chapter is to develop a theoretical framework – an interaction framework. The objective has been to develop a generic interaction framework that easily can be adapted to suit the analysis of any specific relation.

Previously in this thesis it has been emphasized that the theory needed to support decisions regarding the level of interaction is available, but not yet comprehensively compiled. To make the previously presented results more available, the factors that affect the level of interaction has to be packaged in a suitable way.

As seen in the literature review, there are many different ways of presenting research findings. In section 4.1, examples of lists (Fisher, 1997), matrices (Cravens *et al.*, 1996; Fisher, 1997; Lamming *et al.*, 2000), and frameworks (Miltenburg, 1995; Hill, 2000) were shown. While analyzing the research presented in section 4.1, it was concluded that even though the matrices and lists were useful, they provided too little guidance for practitioners, and they could not be used for determining appropriate level of interaction.

The aim of this chapter is to develop a theoretical framework – an interaction framework – that can serve as a foundation for future empirical studies and that subsequently can support companies decision on how to best interact with their suppliers and customers in order to support their products competitive priorities. The interaction framework should hence, not only be used for mapping the current situation, but also for identifying areas of improvement and actions needed to reach an anticipated position.

Earlier research has shown that comprehensive models or frameworks, such as the framework presented by Miltenburg (1995), are suitable tools for companies with limited resources, such as small and medium sized manufacturing enterprises (Greatbanks *et al.*, 1998). Miltenburg's framework aims at determining a comprehensive manufacturing strategy, and might be too complex to use, and would hence not suffice to answer the research questions stated in this thesis.

In this research, a simpler framework, for example based on Hill (2000), is more suitable. There is also a conformance between selecting the appropriate level of process flow based on

internal and external requirements and selecting the appropriate level of interaction based on internal and external factors that can be utilized.

The basic structure in the profile analysis framework by Hill (1985; 1993; 1995; 2000) has been used before as a managerial tool, by other authors, see for example: Platts and Gregory (1992), Pagh and Cooper (1998), Slack and Lewis (2003), and Granell (2007).

Platts and Gregory (1992) and Slack and Lewis (2003) use the profiling model for 'gap-analysis', where the fit between manufacturing performance and market requirement is investigated, based on a number of decision areas and performance criteria.

Hill uses the profile analysis as a comparative method to determine appropriate production process by regarding a number of categories, each comprising a number of aspects. The interaction framework uses the Pagh and Cooper utilize the profile analysis structure to select the right postponement and speculation strategy (P/S-strategy) based on three categories, where each category comprises of a number of decision determinants. Granell uses the structure to determine the appropriate level of automation, based on strategic and tactical decision criterions and factors.

5.1 FRAMEWORK COMPONENTS

The main purpose of the profile analysis is to assist managers in the process of selecting the most appropriate production process (Hill), P/S-strategy (Pagh and Cooper) and also to identify how the alignment between the aspects (decision determinants) and the production process (P/S-strategy) can be improved (Pagh and Cooper, 1998). The profile analysis framework is thus both descriptive (a static picture of how it is now) and normative (what to work on in order to get to where we want to be) (Pagh and Cooper, 1998).

The main purpose of the interaction framework introduced here is to assist managers in the process of selecting the most appropriate level of interaction and to identify how the alignment between the factors (corresponds to decision determinants or aspects) and the level of interaction can be improved. The interaction framework is thus also aiming at being both descriptive and normative.

The profile analysis framework is dissected to identify how it is composed. Hill's product profiling will be used throughout this example.

Initially, three alternative process choices are put on top of the framework since Hill's framework aims at determining which of these process choices that is most appropriate, see Figure 5.1.

Typical characteristics of process choice		
Jobbing	Batch	Line

Figure 5.1 Output from Hill's profile analysis framework (Hill, 2000)

In this research, the aim is to determine the appropriate level of interaction, and hence the rightmost part of the interaction framework will have the three levels of interaction as possible outputs, see Figure 5.2.

Levels of interaction		
Transactional	Collaborational	Integrational

Figure 5.2 Output from the interaction framework

The next component in Hill's framework constitutes the "relevant aspects" that has to be considered. These are first divided into two main categories: products and markets, and manufacturing. Other relevant categories to regard, according to Hill (2000), can be investments and infrastructure, see Figure 5.3.

		Typical characteristics of process choice		
		Jobbing	Batch	Line
Products & Markets				
Manufacturing				
Investment				
Infrastructure				

Figure 5.3 Categories to consider in Hill's framework (Hill, 2000)

In the interaction framework on the other hand, the categories that were identified in chapter 4 are included, i.e. product characteristics, internal characteristics, market requirements, supply chain context, and supply chain relations, see Figure 5.4.

		Levels of Interaction		
		Transactional	Collaborational	Integrational
Product characteristics				
Market requirements				
Internal characteristics				
Supply chain context				
Supply chain relations				

Figure 5.4 Categories to consider in the interaction framework

In Hill's profile analysis framework, several aspects are considered within each category. Hill sometimes calls these aspects 'dimensions'. Each aspect has a scale of possible stages. For example, 'Production volume' can range from low to high, i.e. from a low production volume to a high production volume. The ranges are inserted in the framework so that they correspond to the right process choice. For example, a low production volume is supported by a 'jobbing layout' while a high production volume is better supported by a 'line layout', see Figure 5.5.

Some relevant aspects			Typical characteristics of process choice		
			Jobbing	Batch	Line
Products & Markets	Product range		wide		narrow
	Customer order size		small		large
	Level of schedule changes required		high		low
	Order winners		delivery speed unique capability		price
Manufacturing	Process	technology	general-purpose		dedicated
		flexibility	high		low
	Production volume		low		high
	Set-ups	number	many		few
		expense	inexpensive		expensive

Figure 5.5 Aspects within each category, and their ranges (Hill, 2000)

When categories and aspects have been selected, the next step is to profile the products, customers, or suppliers involved in the interaction. This is done by profiling, i.e. each selected product etc. is positioned on each of the selected dimensions. Since this is a comparative technique, two products, customers, suppliers should be profiled and then compared.

A sample framework, based on Hill, could look like Figure 5.6.

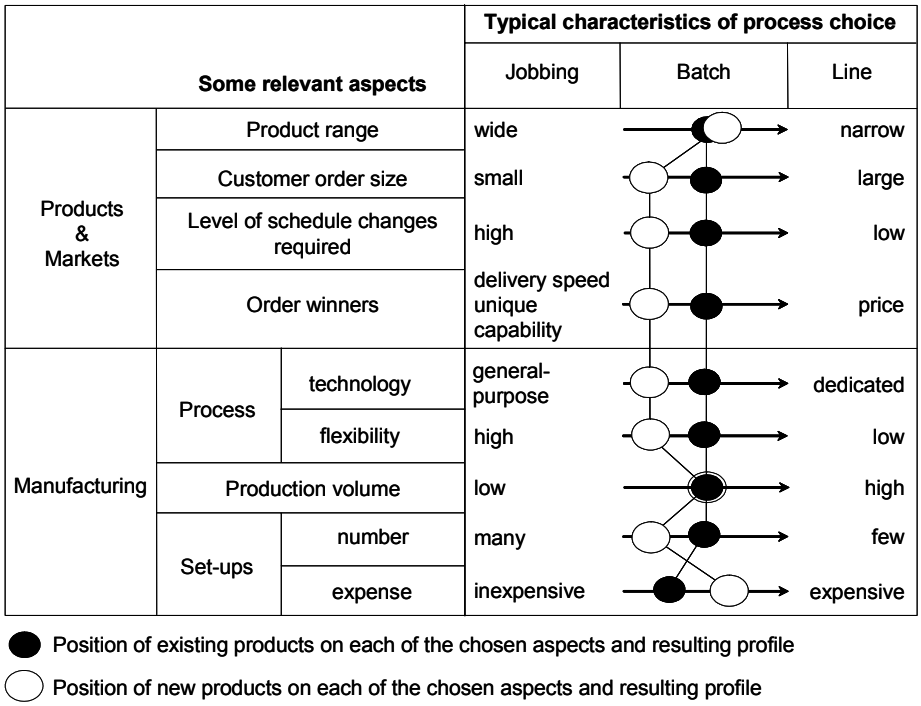

Figure 5.6 A sample product profile, based on the profile analysis framework (Hill, 2000)

In Appendix 1, suggestions of ranges for these factors are presented. The ranges are deliberately set to be generic, i.e. low to high, few to many etc. since the actual number will be specific for each industry or company. The ranges are NOT yet set to correspond to either transactional or integrative level of interaction; the direction of the scale will be discussed in section 5.2.2 below.

5.2 HOW TO USE THE INTERACTION FRAMEWORK

The basic structure of the interaction framework, based on Hill's profile analysis framework is now in place. In the following section, the procedure to use the interaction framework to select appropriate level of interaction is described.

Since the outcome of the profiling will vary for different products, markets, and dyadic relations, each combination has to be analyzed separately. The procedure for profile analysis is however the same:

1) Select factors,

2) Select ranges, or direction of the scale, for the factors, depending on company policy,

3) Profile and analyze the resulting profile.

When the present (or anticipated future) situation is plotted in the interaction framework the emergent profile has to be analyzed. There will rarely be a case where every determinant/factor indicates the same level of interaction. The final decision is therefore always up to the

manager to make. An inconsistency between the factor indication and the selected level of interaction is called a mismatch.

This interaction framework is hence not only a tool to assist managers in the process of selecting the most appropriate level of interaction in each relation or for each product, but also a tool that identifies mismatches between the selected level of interaction and the requirements of the individual factors. Living with mismatches could be strategically sound if the company is aware of its position, and makes its decisions knowingly (Hill, 2000, p. 149).

5.2.1 Select factors

In Table 4.9 - Table 4.14, and in the appendix, the factors that are assumed to affect the level of interaction, based on a synthesis of existing literature are complied and categorized. From all these available factors, only a selection should be used for each profile analysis in the interaction framework. The selected factors should be relevant for the specific interaction that is being investigated. The number of selected factors should be few enough to get an overview of the situation; if the number of selected factors is too extensive, it will blur the importance of the essential factors (Pagh and Cooper, 1998). An insufficient number of factors on the other hand will not reflect the complex reality, and could hence result in the incorrect level of interaction being selected (Pagh and Cooper, 1998).

The resulting interaction framework could then look like Figure 5.7, where a hypothetical interaction framework is illustrated.

Some relevant factors		Levels of Interaction		
		Transactional	Collaborational	Integrational
Product characteristics	Complexity			
	Criticality			
Market requirements	Delivery speed			
	Delivery precision			
	Level of demand			
Internal characteristics	Process flexibility			
	Capacity buffer			
	Product mix			
Supply chain context	Number of suppliers			
	Market position			
	Number of competitors			
Supply chain relations	Trust			
	Power			
	Frequency of interaction			

Figure 5.7 An interaction framework with some selected factors

5.2.2 Select direction for the ranges for each factor

In the appendix, suggestions of ranges for the factors are presented.

The ranges are not yet set to correspond to either transactional or integrative level of interaction. The direction of the scale for each factor will depend on, on two things; how the factor affects the interaction and on company policy.

For some factors, the direction of range is clear. For example, a low level of trust corresponds to a low level of interaction – a transactional relation, while a high level of trust enables a higher level of interaction.

An example of an interaction framework with ranges for each factor in place is illustrated in Figure 5.8.

	Some relevant factors	Levels of Interaction		
		Transactional	Collaborational	Integrational
Product characteristics	Complexity	low		high
	Criticality	low		high
Market requirements	Delivery speed	important		non-important
	Delivery precision	non-important		important
	Level of demand	high		low
Internal characteristics	Process flexibility	multi-purpose		dedicated
	Capacity buffer	none		infinite
	Product mix	wide		narrow
Supply chain context	Number of suppliers	many		one
	Market position	leader		follower
	Number of competitors	few		many
Supply chain relations	Trust	low		high
	Power	high		low
	Frequency of interaction	low		high

Figure 5.8 The interaction framework with selected factors and their ranges

Fore some of the factors is the direction of the range not as unambiguous. Examples of when the direction of the scale is not intuitive are given below. The examples are based on how the competitive priorities are supported by different levels of interaction.

- Should suppliers, when delivering poor quality, be supported to increase their quality or be reprimanded and replaced? The company policy of supplier treatment will affect two things; if the factor is included in the interaction framework and the direction of the scale – is quality best supported in a low or high level of interaction with suppliers?
- The strategy when choosing supplier based on cost is closely connected to the over all business strategy. Should the supplier with the lowest price or the supplier with the best overall solution be selected? Is the cost strategy for the company best supported by a transactional or an integrative relation?
- A crucial requirement for being able to achieve high delivery performance is enough capacity. This applies to the suppliers, the focal firm, and for the distributors. When selecting a level of interaction, the actor has to decide if they want a higher level of interaction, with presumably only a few reliable suppliers and distributors, and hence relatively fixed capacity. Alternatively, if they instead aim at a lower level of interaction where the number of possible suppliers, and thereby the possible capacity is nearly infinite, but less reliable?
- What type of flexibility is needed from the supplier? Is the supplier included in the development process of a new product, or is the supplier selected after the product is

designed, based on the product characteristics? Also, is flexibility needed from the distributor, and if so, what type?

- If innovativeness is the most important competitive priority of all the market requirements, it will then have a great impact on the level of interaction decision. Is a high level of interaction where for example pioneer work and classified information can be shared, sought-after? Alternatively, is the innovation composed of standard components that can be sourced anywhere?

The implication due to the inconsistent direction of ranges is discussed in the section 'framework limitations'.

5.2.3 Profiling and analysis

The next step is to profile the product, the supplier, or the relation and then to analyze the level of correlation between product demand, market requirements, current supplier relation etc (the categories). If the profiling reveals a mismatch between different categories or factors, the company has three different ways to deal with this. These are, according to Hill (2000):

1. Live with the mismatch
2. Alter the mismatching factors
3. Alter the level of interaction

In some situations, where one or few factor(s) restrain which level of interaction that can be implemented, the work of using the interaction framework and yet ending up living with the mismatch can seem tiresome. This is however still beneficial for the company. In the process of using the interaction framework, the decision makers have had the opportunity to increase their awareness of which factors that affect their interactions, and how. In addition, being aware that the present level of interaction does not support the current situation is important knowledge.

CHAPTER 6

DISCUSSION AND FUTURE RESEARCH

CHAPTER INTRODUCTION

This chapter contains a discussion of the degree to which the research has answered the research questions and fulfilled the research objective and aim. A reflection over scientific and industry contribution is presented. Ideas for future research are also stated.

6.1 EVALUATION OF THE INTERACTION FRAMEWORK

The interaction framework is based on a theoretical synthesis of previous literature. The frameworks presented in previous literature are in their turn synthesized from empirical studies and theories. The interaction framework will hence have some inherited benefits and limitations, in addition to those originating from the development of this framework.

6.1.1 Framework benefits

The resulting profile from the interaction framework illustrates the degree of consistency between the different categories. It therefore provides the decision maker with a comprehensive view of the current situation.

Since the profile analysis technique originally is a comparative technique, different solutions (where the product, the supplier, or the internal prerequisites can be altered) can be compared with each other in order to find an adequate level of interaction.

6.1.2 Framework limitations

From the interaction framework, it can be concluded what level of interaction that is appropriate, based on the selected factors. The framework does not state what type (i.e. long-term contracts, joint venture etc.) of interactions that should be used. Moreover, the interaction framework supports decisions at a strategic level but does not support the operational realization of the selected level of interaction. The interaction framework does not offer any explicit answers; it is just intended to be a decision support.

Since the interaction framework has not yet been empirically tested, it should be viewed as a hypothesis of how the tested and verified interaction framework will look like.

Even if the intention of the interaction framework is to make it applicable and easy to understand, most companies will have several products to manufacture and distribute, and

hence participate in several supply chains. To make best use of the framework, some prioritizing of the products has to be done. The question regarding how to choose what products and markets to start with will not be answered in this thesis.

The interaction framework cannot currently consider different importance or 'weights' on the factors. All factors are hence weighted equally.

The factors in this thesis are listed under the categories that need to be considered. Another solution could be to list the factors according to the business processes they affect. This would support the statement that each dyadic relation constitutes several business processes and the different processes can have different levels of interaction. This could perhaps increase the applicability by lowering the number of factors that the decision maker has to regard when selecting "relevant factors".

The main limitation however, is probably that in contrast to Hill's profile analysis; the direction of ranges in the interaction framework is ambiguous. The reasons for this ambiguity could be many. It could be due to the undefined nature of the supply chain interaction area. It could be due to that levels of interaction are not as mutually exclusive as process choices or as P/S-strategies. A more probable reason is however, that the factors are defined too widely. For example, the factor 'Number of suppliers' within the supply chain context category would give more guidance for the direction of range if it would be more clearly defined as 'Number of available suppliers – when raw material is scarce', or 'Number of available suppliers – holding a specific capability'.

6.2 DISCUSSION

The interaction framework is mainly a managerial tool and might thus be mainly a contribution to industry. The academic contribution would be the compilation of affecting factors and the categorization of these factors.

The managerial implication is that actors, with just spending a little time and effort, can increase their competitiveness. The reason for this is that when the level of interaction is appropriate for the products' competitive priorities, the energy spent on maintaining a relation is energy spent on the right thing. The proposed interaction framework can increase an actor's competitiveness by facilitate the selection of appropriate level of interaction with suppliers or customers in their supply chain.

6.2.1 Fulfillment of research objective

In chapter 3, the terminology and characteristics of supply chains and supply chain interactions were investigated. The basic supply chain components, different supply chain system levels and the direction and extent of supply chain interaction were defined. It was concluded the supply chain interaction should be analyzed at system level 2 – within the dyadic relation. The relation could be with an actor either horizontally or vertically in the supply chain. The content of the interaction were defined as different business processes, where each process can have different levels of interaction. The chapter vas concluded with an explanation of levels of interaction, where the characteristics of transactions, collaborations, and integrations were described.

In chapter 4, five categories were found affecting the appropriate level of interaction:

- Product characteristics
- Supply chain context

- Internal process
- Market requirements
- Supply chain relations

These five categories were then operationalized into a number of factors (decision aspects). Not all of these factors will be relevant to consider when selecting level of interaction and hence is a decision tool needed.

An interaction framework was consequently developed to support decisions regarding level of interaction. The decision is supported by compiling relevant factors and plotting the trade-offs between different levels. The resulting profile provides the decision maker with a comprehensive view of present (or anticipated future) state.

Research question 1, 2, and 3 are hence answered and the objective of this thesis is fulfilled. The degree to which this thesis manages to fulfill the aim of this research however is still left to investigate.

6.3 FUTURE RESEARCH

Next in this research project, an empirical study will be carried out, where the aim is to investigate if any category that is important to consider has been omitted. The empirical study should also test if the included factors are relevant for practitioners and if all relevant factors are included.

Since the present situation affects what level of interaction that is appropriate, both comparative studies between similar actors and longitudinal studies where one actor is studied in several situations are of interest.

The aim of the future research is to refine the interaction framework and then to present it as a decision support tool. In order to work as a managerial tool, the interaction framework has to be supplemented with a prioritizing tool to guide managers as to what relations and what products to start with, in order to gain the biggest improvement.

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APPENDIX CHAPTER

APPENDIX

FACTORS WITHIN THE PRODUCT CHARACTERISTICS CATEGORY, AND THEIR RANGES

Product characteristics	Range	
Life cycle phase	Start-up	End
Life cycle length	Long	Short
Contribution margin	Low	High
Product variety	Low	High
Forecast error	Low	High
Stock-out rate	Low	High
End of season markdown	None	Yes
Lead time	Short	Long
Product type	Standard	Special
Frequency of product changes required	Low	High
Frequency of schedule changes required	Low	High
Throughput time	Short	Long
Time-to-market	Short	Long
Innovativeness	Low	High
Innovation	Incremental	Radical
Novelty	Low	High
Criticality	Low	High
Uniqueness	Standard	One-of-a-kind
Material substitution	Possible	Impossible
Strategic importance	Non-important	Important
– Value added	Low	High
– Percentage of raw material in total cost	Low	High
– Impact on profitability	Low	High
Complexity	Low	High
Number of components	Few	Many
Commonality of components	Low	High
Number of product functions	Few	Many
Linkage between sub-systems	Few	Many
Sequence of manufacturing	Important	Non-important
Type of manufacturing	Manual	Automatic
Product/process interdependence	Low	High
Quality	Low	High
Features	Few	Many
Style and design	Standard	One-of-a-kind
Value profile (where value is created)	By focal firm	By supplier/customer
Monetary density	Low	High
Share of service included	Low	High

FACTORS WITHIN THE INTERNAL PROCESS CATEGORY, AND THEIR RANGES

Internal process	Range	
Criticality	Low	High
Complexity	Standard	Unique
Process technology	General purpose	Dedicated
Process flexibility	Dedicated	Multi-purpose
Level of capital investment	Low	High
Economies of scale	Small	Large
Capacity	Low	High
Capacity buffer (production)	None	Infinity
Capacity buffer (administration)	None	Infinity
Special capabilities	No	Yes
Employee capabilities	Low	High
Production volume	Low	High
Product-mix range	Narrow	Wide
Ability to cope with product change	Easy	Difficult
Ability to cope with schedule change	Easy	Difficult
Setup – number of	Few	Many
Setup – expense	Cheap	Expensive
Key manufacturing task	-	-
Pace of technology substitution	Low	High
Manufacturing focus	Utilization rate	Capacity buffer
Inventory strategy	Minimize	Use
Lead time focus	No	Reduce
Supplier approach	Cost Quality	Speed Flexibility Quality
Product design	Max performance Min cost	Modular design Postponement
Need for control	Low	High
Need for flexibility	Low	High

FACTORS WITHIN THE MARKET REQIOREMENTS CATEGORY, AND THEIR RANGES

Market requirements	Range	
Order winners	-	-
Quality	Important	Non-important
Delivery speed	Important	Non-important
Delivery dependability	Important	Non-important
Delivery precision	Important	Non-important
Delivery time (required)	Short	Long
Delivery frequency	Often	Seldom
Cost	Important	Non-important
Flexibility	Important	Non-important
Innovativeness	Important	Non-important
Performance	Important	Non-important
Customer order size	Small	Big
Customer order size	Level	Varying
Level of demand	Low	High
Uncertainty of demand	Low	High
Target segment	Mainstream	Unique
Seasonality	None	High
Trend	None	In/de-creasing
Rate of new product introductions	Low	High
Cost of non-delivery	Low	High
Cost of non-quality	Low	High

FACTORS WITHIN THE SUPPLY CHAIN CONTEXT CATEGORY, AND THEIR RANGES

Supply chain context	Range	
Number of competitors	Few	Many
Competitor introduction	Few	Many
Competitive demand	Low	High
Rate of competitor introduction	Low	High
Entry barriers	Low	High
Market share	Low	High
Number of customers	Few	Many
Distance to customers	Proximity	Distant
Number of suppliers	One	Many
Suppliers capacity utilization (Risk for supply bottleneck)	Low	High
Supplier product uniqueness	Unique	Common
Distance to supplier	Proximity	Distant
Logistics cost	Low	High
Pace of technology introductions	Low	High
Market position	Follower	Leading
Profit margin	Low	High
Raw material supply	Scarce	Infinite
Rules and regulations	Few	Many

FACTORS WITHIN THE SUPPLY CHAIN RELATIONS CATEGORY, AND THEIR RANGES

Supply chain relations	Range	
Trust	Low	High
Power	Low	High
Bargain power	Low	High
Time frame	Short	Long
Maturity	Low	High
Frequency of interaction	Low	High

APPENDED PAPERS

The appended papers have been reformatted concerning layout. Also, some minor changes have been made concerning figures and spelling.

PAPER 1

A REVIEW OF SUPPLY CHAIN CLASSIFICATIONS

Bäckstrand, J., and Sandgren, A., A Review of Supply Chain Classifications, *Proceedings from PLAN's 7th Research and Application Conference on Logistics and Operations Management*, Borås, Sweden, 2005

A REVIEW OF SUPPLY CHAIN CLASSIFICATIONS

Jenny Bäckstrand and Andreas Sandgren

ABSTRACT

This is a theoretical paper based on a literature review of supply chain classifications where a classification taking both product characteristics and collaboration type into consideration is sought. The purpose of this review is to find areas of overlapping research as well as areas where research is lacking. The review shows that the wanted classification dimensions are used in different existing classifications, but not yet explicitly mapped to each other. The potential for future research is hence indicated.

INTRODUCTION

The increased competition and the rapid globalization of the market make the need for companies to establish efficient supply chain collaborations clear. An increased demand for knowledge on how to establish efficient collaborations between companies is identified by both practitioners and academics. The question is not whether to establish relationships with other organizations or not, but rather how and with which partners (Cravens *et al.*, 1996). A frequent solution is to co-operate in supply chains or supply chain networks where the actors try to choose partners that will support resource efficiency. One emitting question is then what is a supply chain or supply chain network? And is there more than one way to co-operate? Despite the great interest practitioners as well as researchers have shown for the subject there are still lacking unambiguous definitions of supply chains and supply chain networks. The aim of this paper is to shed light on present supply chain classifications based on collaboration. The purpose is to create a theoretical basis that a classification of supply chain collaboration later can be developed from. The main issue is to make this classification applicable to producing companies. This paper is a literature review of the existing literature concerning supply chain classifications. The selection of literature to review was iterative. When an article was found relevant, the reference list was used to trace the original source and/or other articles covering this subject.

SUPPLY CHAINS AND SUPPLY CHAIN NETWORKS

One of the companies in a supply chain is generally viewed as the focal company. This is usually the main company in a supply chain based on the key product, see Figure 1. When an organization describes their supply chain, they most often consider themselves as the focal company in order to identify suppliers and customers.

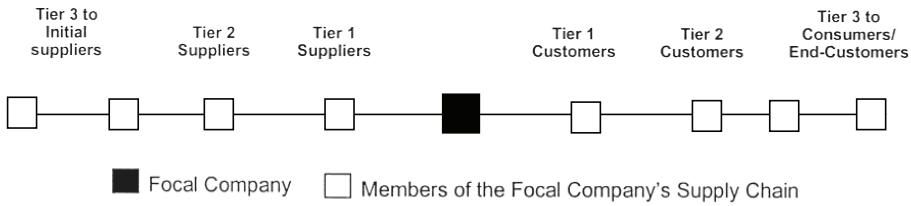

Figure 1 Supply chain structure with focal company, suppliers and customers

Normally there are several companies involved in a products path from raw material to end customer. Mentzer *et al.* (2001) define a supply chain as:

> *"A set of three or more entities (organization or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from source to a customer".*

Since this definition is both commonly recognized and adequate and it is not the purpose of this paper to develop new definitions or classifications, we will agree to the definition proposed by Mentzer *et al.* In a supply chain the upstream and the downstream flow usually refers to the direction of flow from the focal company's point of view (Womack *et al.*, 1990; Christopher, 1998; Womack and Jones, 2003). The upstream chain is also called the production chain. The production chain consists of suppliers in different tiers. The upstream flow mainly consists of information and finances but also products or material in the form of returns. The downstream chain, or the distribution channel, consists of the focal company's customers and the customer's customer. The main downstream flow is the flow of products or material even though information and service also is important.

Supply chain networks can be defined as a set of interconnected supply chains, describing the total flow of goods and services from original sources to end customers, from a focal company's point of reference (Harland, 1996), see Figure 2. Instead of the linear and unidirectional model describing supply chains, the supply chain network concept includes and describes lateral links, reverse loops, two-way exchanges etc. (Lamming *et al.*, 2000). In this paper, when the term supply chain is used it comprehends both supply chain and supply chain network characteristics.

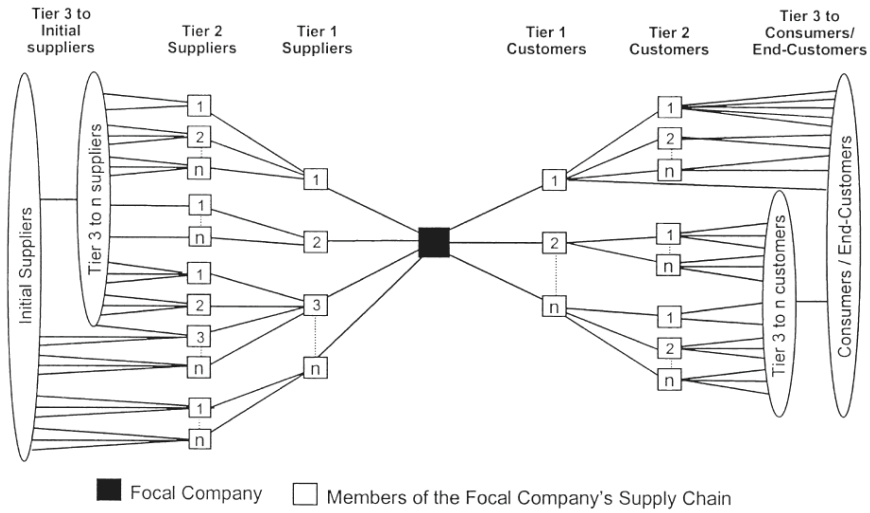

Figure 2 Supply chain network structure. Adopted from Lambert et al. (1998)

Relations in supply chains

Initially a distinction between the intra-business and the inter-business integration needs to be made. Intra-organizational relationships, or the internal supply chain, integrate business functions needed to create a flow of materials and information from the inbound to the outbound ends of the business (Harland, 1996). The inter-organizational relationship, or the external supply chain, concerns the relations between different actors. Please observe that the actors could be different entities of the same company. In this review of classifications, the focus is mainly on the inter-organizational relationships.

The vertical relations are inter-business relations between actors in different tiers. The complete vertical chain links the initial supplier to the end-user. See also Figure 3. Vertical integration is when an actor increases its ownership to include other actors in different tiers. Vertical integration is usually focused either up-stream towards the initial supplier or down-stream towards the end-customer.

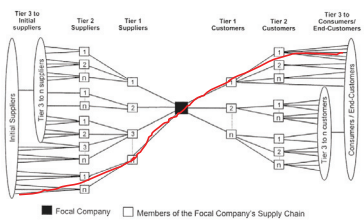

Figure 3 The vertical relationship, based on Lambert et al. (1998)

The horizontal relation is composed of relations within the same tier, see Figure 4. Since the companies within the same tier play the same role in a supply chain the relations are between actual or potential competitors (Cravens *et al.*, 1996). Why would any company want to form alliances with similar companies competing on similar markets? The incentives for horizontal relationship are in fact many. It could be the prospect of together being able to act as *one*

towards a dominant supplier or customer. Together they could develop a particular technology (Hinterhuber and Levin, 1994). Another reason could be the ability to accept overwhelming orders by splitting the workload. Or even the advantages of a cartel situation where it is no longer a customer's market.

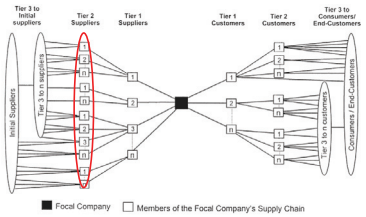

Figure 4 The horizontal relationship, based on Lambert et al. (1998)

Extent of supply chains

The research within supply chain management can according to Harland (1996) be divided into four different system levels, see Figure 5. Even though this classification originates form the management of supply chains, the same system levels are relevant when determining the scope of supply chain collaborations. These system levels will serve as reference when discussing the following classifications.

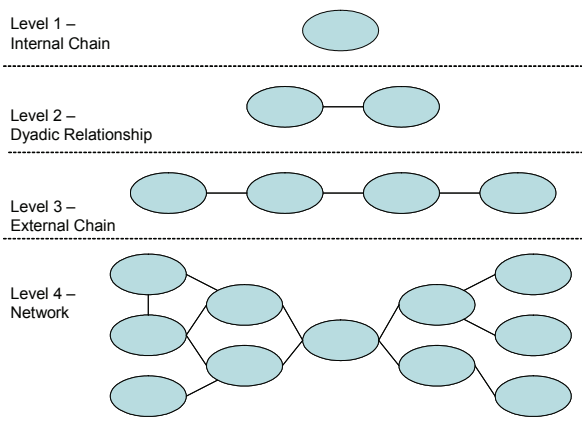

Figure 5 The system levels of supply chain management, Harland (1996)

Mentzer *et al.* (2001) also proposes a four step model, similar to Harland's. They too support the notion of evolution from simpler setups towards more complex ones. (Sørensen, 2005)

The system levels according to Harland (1996) are:

- The internal chain - within an organization.

The inter-business relationships can then be divided into three different levels:

- The dyadic or two party relationships.

- The external chain relationship where the supplier, the supplier's suppliers, the customer and the customer's customers and so on are included, i.e. a set of dyadic relations.
- The network of interconnected businesses.

Hulthén (2002) has a similar classification and states that the context of which a company is surrounded, can be described in three dimensions: an activity layer, a resource layer and an actor layer. The activities are linked to each other in a network-like structure. The following classification is made, originating from Alderson (1965):

- The transformation - A change in the physical product.
- The transaction - An exchange agreement between two actors.
- The transvection - The outcome of a series of transactions, related to all the activities required to land an end-product in the hands of a unique end-user.

There are many similarities between Harland's and Hulthén's classifications. The transformation process is similar to the internal chain, the dyadic relation similar to a *set* of transactions and the external chain to the transvection. The fourth level, the network level according to Harland's classification, has no parallel in Hulthén's framework. However the same phenomenon is described by Hulthén and called "crossing transvections". Compare that to the definition of supply chain networks in Harland (1996): "Supply chain networks can be defined as a set of interconnected supply chains" and the conformity is complete.

CLASSIFICATIONS

Initially some starting points for classifications were identified. First a distinction was made in accordance to what system level in Figure 5 the author clamed the classification was valid at. Then the dimensions of supply chain priorities, product characteristics and organizational structures were applied. Since none of the found classifications integrated supply chain collaboration and hence did not meet the requirement of being applicable for producing companies, additional dimensions were added. The additional dimensions were the level of ownership; the degree of relationship, the degree of environmental volatility and manufacturing process.

PRIORITIES OF THE SUPPLY CHAIN

An already classical classification of supply chains (system level 3) was made by Fisher in (1997), see Figure 6. He emphasized the impact of product characteristics on the supply chain priorities and identified two different types of supply chains, the physically efficient chain and the market responsive chain. These types of chains are appropriate for distributing products with certain characteristics and the collaboration within the chains has different priorities.

The physically efficient chain supplies a predictable demand efficiently at the lowest possible cost. Cost cutting is achieved by close coordination or competitive negotiations with the supplier. The market responsive chain responds quickly to unpredictable demand in order to minimize stock-outs, markdowns and obsolete inventory. The suppliers in this type of chain are evaluated by speed, flexibility and quality.

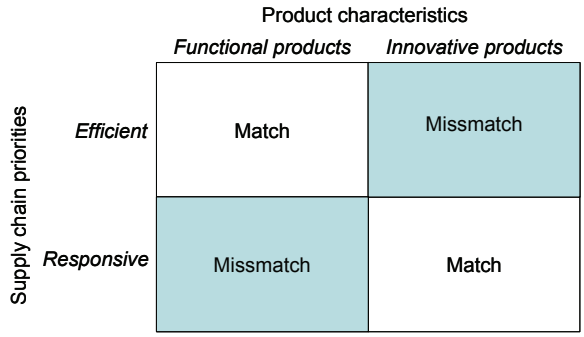

Figure 6 Matching supply chains with products. Adapted from Fisher (1997)

In the model by Fisher, no examples of appropriate types, levels or time-frames for collaborations are given but the model is still relevant for producing companies due to the focus on product characteristics.

Lamming *et al.* (2000) have, with Fisher's ideas as a starting point, developed a model for classification of supply chain networks. They have also used the product characteristics as a differentiator but extended the aspects of the product to include, not only innovativeness but also uniqueness and complexity. Further on they argue that since companies want to protect their unique resources in order to gain competitive advantage it is expected that they exercise carefulness in sharing these resources with other parties. Therefore they make the distinction between supply chain networks of innovative-unique products and supply chain networks of functional products, see Figure 7. This will also affect the nature of information and knowledge sharing and thereby the level of collaboration in the supply chain network.

Supply Network Characteristics

Product complexity	*Innovative and unique products*	*Functional products*
High	*Competitive priority:* Speed and flexibility Innovation Quality supremacy *Sharing of resources and information:* Large amounts of non-strategic information – enabled by IT problematic when involving sensitive information and knowledge	*Competitive priority:* Cost reduction Quality sustainability Service *Sharing of resources and information:* Large amounts of non-strategic information – enabled by IT generally unproblematic, may include cost breakdowns
Low	*Competitive priority:* Speed and flexibility Innovation Quality supremacy *Sharing of resources and information:* Problematic exchange of sensitive information and knowledge IT less critical	*Competitive priority:* Cost (by high volume production) Service *Sharing of resources and information:* Generally unproblematic - may include cost and strategic knowledge IT less critical

Figure 7 Classification of supply chain networks. Inspired by Lamming et al. (2000)

ORGANIZATION WITHIN A SUPPLY CHAIN

Instead of the network abilities, Snow *et al.* (1992) based their classification on network organizations and identified three different types of network organizations. Each of these organizational structures is distinctly suited to a particular environment.

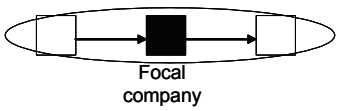

Figure 8 Internal network

The internal network in Figure 8 arises to capture entrepreneurial and market benefits without much outsourcing. The focal company owns most or all assets associated with a specific business. The internal network could be compared to high vertical integration.

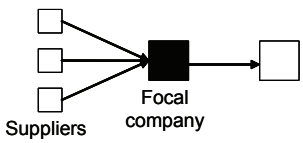

Figure 9 Stable network

Figure 9 illustrates a stable network where the focal company employs partial outsourcing to increase flexibility in the value chain. The assets are owned by several firms and the relationship to the focal company is therefore important.

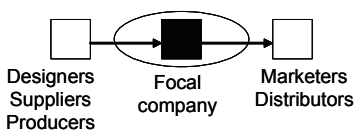

Figure 10 Dynamic network

Extensive outsourcing to handle discontinuous competition or short life-cycles is the characteristics of the dynamic network in Figure 10. The assets are owned largely by different firms in the network. The focal company acts more or less as a broker. This could be compared to a market responsive chain (Fisher, 1997).

Lin *et al.* (1998) describe three different kinds of supply chain networks which they call Type I, Type II and Type III networks. This classification of the networks can be compared with the materials profile classification described in Olhager (2000). This illustrates the importance of building a supply chain network suitable for the core product.

- Type I networks are convergent and appropriate when excess inventory should be avoided. The reason could be that final product or some detail carries a high stock keeping cost. The final assembly is made at the focal company and this type of network can be compared to the stable network in Figure 9. In the Type I network long-term relations are common. Examples of industries are the automotive and the airplane industries. The corresponding materials profile is called the A-profile.

- The Type II network is divergent and components are common to many product models and can be combined into a number of end-products. The network is composed of two parts. In the first part of the network generic models are produced and assembled in complex manufacturing processes, in-house at the focal company. The second part contains less complex assembly processes where customized models are put together. The motivation for a Type II network is to gain mass production advantages and at the same time being able to offer a great variety of products. The largest obstacle to being successful in producing custom made products in this type of network is the lead time. Therefore the customization should be postponed as far down-stream as possible. Examples of industries are the electronic and computer industries. The corresponding materials profile is called the T-profile.
- When ability to react to changes on the market is crucial, networks of Type III is the most appropriate. The manufacturing process uses the divergent differentiation approach and the differentiation into different product models is made at the manufacturing stage. A large variety of end products will create problems given that the product life cycle is short for this type of products. The product life cycle ranges normally from a couple of weeks to a few months. This will lead to problems since the manufacturing has to be based on forecasts – *build-to-forecast*. The difficulty lies in creating reliable forecasts when lacking historical data to analyze. Example of companies in this type of network is within the fashion industry. The corresponding materials profile is called the V-profile.

This classification regards the market requirements and by deduction also the product characteristics but except the statement that long-term relations are common in Type I networks, no connections are made with types or levels of collaborations.

Where as Snow *et al.* (1992) and Lin *et al.* (1998) focus on the layout or the delimitations of ownership of the network, Cravens *et al.* (1996) have developed a stereotypical model of network organizational forms, see Figure 11.

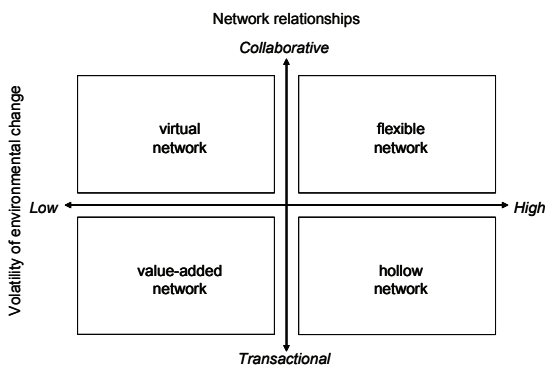

Figure 11 Classification of network organizations. Source: (Cravens *et al.*, 1996)

The different network forms are based on two dimensions of classification: the volatility of environmental change and the type of relationships among the network members. The volatility reflects characteristics such as speed, degree, unpredictability and uncertainty of radical changes in the environment. The types of relationships among member in the network range from collaborative to transactional. The four network forms are as follows:

- Hollow network - Transaction based organization associated with highly volatile environment. The core organization depends heavily on other organizations to satisfy customer needs. It is appropriate in highly segmented markets where customer needs are differentiated. Provides the flexibility to shift to new opportunities and new sources of supply.
- Flexible network - High environmental volatility and long-term intra-organizational collaboration. The network coordinator identifies customer needs, designs products and establishes sources of supply. This type is likely under conditions of asset specificity. The market environment involves fast response times, high added-value and high risk.
- Value-added network - Associated with markets where preferences are diffused and segments hard to define but the volatility is relatively low. Most relationships tend to be transactional. Fits markets with no complex technologies and customized products. Member of the network perform tasks at a low cost.
- Virtual network - A limited reformation of the traditional organization where the core company seeks to establish collaborative relationships with other firms. The network is likely to possess core competency. It also has a long-term orientation with the goal of meeting the sometime complex needs of the segmented market. The members of the network provide a buffer to the core organization against risks and uncertainties.

In this classification the relationships in the supply chain network is taken into consideration. The network relationship dimension that ranges from transactional to collaborative can be translated into ranging from a low level to a high level of collaboration. The stereotypical model proposes no appropriate types of collaborations within these levels. Even though the product characteristics are not explicitly mapped in this model, the order winners and order qualifiers on the market can be interpreted in the explanations of the network forms.

In his recent dissertation Selldin (2005) tests both Fisher's (1997) categorization of products and supply chains and the product-process matrix developed by Hayes and Wheelwright (1979) in a survey among Swedish manufacturing firms, performed in 2001. When testing to align the models by Fisher and Hayes and Wheelwright, the study shows that the product structure characteristic in the product-process matrix does not drive the choice of supply chain design. However there is a tendency, but not a statistically significant one, towards a fit between the product and the supply chain design. Olhager *et al.* (2004) suggests an explanation for this weak conformity: companies does not necessarily treat the supply chain types in Fisher (1997) as mutually exclusive. The phenomenon of combining the characteristics from both supply chain types in order to expand the company's operational efficiency is called supply chain frontier (Selldin and Olhager, 2002).

CONCLUSION

Different classifications have been identified based on system level, supply chain priorities, product characteristics, organizational structures, level of ownership, level of relationship, level of environmental volatility and manufacturing process. Classifications based on system levels are an area with much overlapping research (Alderson, 1965; Harland, 1996; Mentzer *et al.*, 2001; Hulthén, 2002).

When extending the classification dimensions the overlapping, if any, became less evident. There are in fact a few existing supply chain classifications taking the product characteristics

into consideration, but then the connection to the appropriate type of collaboration is missing (Fisher, 1997; Lamming *et al.*, 2000). Other classifications focused on the organization structure (Snow *et al.*, 1992; Lin and Shaw, 1998) and briefly touched the dimensions of product characteristics and level (instead of type) of collaboration without offering a complete mapping.

When the dimension of relationships were taken into consideration, the product characteristics were instead omitted (Cravens *et al.*, 1996). The work of Selldin (2005) does concern both supply chains and product characteristics, but does not use the dimension of supply chain collaboration.

In the competitive world of today producing companies, in particular small and medium sized companies need an easy comprehensible framework in order to facilitate the selection of collaboration type appropriate for the product characteristics. This would increase their competitiveness by supporting the products order winning criteria. The conclusion is that there is still a supply chain classification integrating the appropriate type of collaboration and the product characteristics missing.

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PAPER 2

REVIEW OF SUPPLY CHAIN COLLABORATION LEVELS AND TYPES

(SUPPLY CHAIN INTERACTION – CHARACTERISTICS AND AFFECTING FACTORS)

Bäckstrand, J., and Säfsten, K., Review of Supply Chain Collaboration levels and types, *Proceedings from the 1st International Conference in Operations and Supply Chain Management,* Bali, Indonesia, 2005

SUPPLY CHAIN INTERACTION – CHARACTERISTICS AND AFFECTING FACTORS

Jenny Bäckstrand, Kristina Säfsten

ABSTRACT

Supply chain collaboration is a growing area of research attracting both practitioners and academics due to the performance benefits among participating members. However, the question how companies should select the way they interact with other actors within the supply chain in order to best support the products being manufactured and distributed, is still left unanswered. In this paper, a first step towards a framework supporting the design of supply chain interaction is presented. The aim of this paper is to clarify the characteristics of supply chain interaction, both in terms of different levels of interaction and concerning factors affecting the appropriate level of interaction. It is necessary to explain the content of the different levels and types of interaction in order to facilitate rational decisions concerning the appropriate type of interaction for each of a company's relations. The characteristic of supply chain interaction is described as well as a number of factors affecting the level of interaction.

Keywords: Supply chain interaction, definition of collaboration, framework

INTRODUCTION

With the growing globalization of the market, it has become increasingly important for all companies to improve their competitiveness. This is particularly important for small and medium sized manufacturing companies that face an ever growing number of low-wage competitors. The question is no longer whether to establish relationships with other organizations or not, but rather how and with which organizations (Cravens *et al.*, 1996). Many researchers do point out the importance of collaboration within supply chains (e.g. Christopher, 1998; Horvath, 2001; Sahay, 2003). Supply chain collaboration facilitates the cooperation of participating members along the supply chain in order to improve the overall performance (Bowersox, 1990). Examples of benefits from collaboration include revenue enhancements, cost reductions, and operational flexibility to cope with high demand uncertainties (Fisher, 1997; Lee *et al.*, 1997; Simatupang and Sridharan, 2005). Both practitioners and academics are due to these potential benefits becoming more and more interested in supply chain collaboration (Corbett *et al.*, 1999; Horvath, 2001).

The intention of the majority of previous supply chain collaboration research has been to propose measures of the degree to which a company interacts with its partners in a supply chain, without considering if the relationship really is collaborative or not (Simatupang and Sridharan, 2005). Bengtsson *et al.* (1998) for example define different types of collaboration as complete ownership, joint ownership, joint venture, long-term contract, purchase option, and short-term contract. Webster (1992) proposes another definition with a continuum from pure transactions to fully integrated hierarchical firms. Both these definitions include

ownership and Webster also includes pure transactions, which not really can be considered as collaboration.

Hence, a distinction between interaction and collaboration has to be made. In this paper, the term *interaction* includes all forms of contact between companies. When the interaction is collaborative, the term *collaboration* is used. The phrase *supply chain collaboration* is used when the original author uses these words.

Even though the terminology is far from consistent, several authors have attempted to provide technical solutions for collaboration strategies (Holweg *et al.*, 2005) or collaboration concepts (Skjøtt-Larsen, 1999) without stating for which type of interaction these strategies and concepts are appropriate. The research findings, even though relevant, are consequently not directly applicable for companies. This tendency is also noted by Brenchley (2004) who states that many organizations are getting too embroiled in the technical process of collaborative planning, forecasting, and replenishment (CPFR), rather than focusing on its objectives of cutting costs and improving service and value.

Furthermore, the question how companies should design their supply chain collaboration in order to best support the products being manufactured and distributed is still left unanswered. This absence of research on how to interact in a supply chain to best support the product has been highlighted in a previous paper (Bäckstrand and Sandgren, 2005). The correlation between supply chain design and product characteristics has in fact been discussed in Selldin (2005) but the aspect of interaction was not treated. In a survey among Swedish manufacturing firms, the correlation between the models by Fisher (1997) and Hayes and Wheelwright (1979) was studied. The study showed that the product structure characteristic in the product-process matrix does not drive the choice of supply chain design. However there is a tendency, but not a statistically significant one, towards a fit between the product and the supply chain design. Olhager *et al.* (2004) suggest an explanation for this weak conformity: companies do not necessarily treat the supply chain types in Fisher (1997) as mutually exclusive. The phenomenon of combining the characteristics from both supply chain types in order to expand the company's operational efficiency is called supply chain frontier (Selldin and Olhager, 2002).

The aim of this paper is to identify the characteristics of supply chain interaction and also to define collaboration. It is necessary to explain the content of the different levels and types of interaction in order to facilitate rational decisions concerning the appropriate type of interaction for each of a company's relations. The appropriate level and type of interaction for manufacturing and distributing a specific product is assumed to be affected by a number of factors. In this paper the factors associated with the interaction are presented. There are also several factors concerning the product characteristics and the products order winners and order qualifiers for different markets that will influence the proper interaction type. These factors will not be discussed further in this paper. This will create a basis for a future framework supporting decisions concerning appropriate interaction levels and types. The first step towards this framework is a common terminology of use for both practitioners and academics.

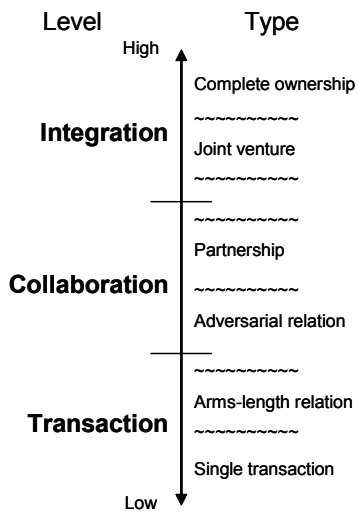

Figure 1 Levels and types of interaction

A common terminology will assist primarily small and medium sized companies to assimilate previous and future research. The result presented in this paper is based on a literature review. The article selection is deliberately multi-disciplinary in order to identify the contrasting themes and antecedence of the field.

LEVELS OF SUPPLY CHAIN INTERACTION

The degree of interaction between two organizations can be described as a continuum, ranging from a single, non repeated transaction to a full merge into one organization. Within this scale three different main levels are identified, namely transaction, collaboration, and integration. Each main level also contains a continuum of relationship types, see Figure 1.

Only when the differentiation between the levels of supply chain interaction is clear, supply chain interaction types can be discussed. In this paper, the term 'relation' is used for all sorts of interaction between companies, regardless if the interaction is adversary or amiably.

TRANSACTION

Transaction is commonly known as the exchange or transfer of goods, services or funds. A transaction focuses on the single product transaction with limited information sharing and was the dominant relation form during the 70's and 80's. These trade exchanges involved tough price negotiations were the buyer relation was adversary and the goal was to increase the individual company's profit. These forms of relations, also known as arm's-length relations are characterized by distrust and competition (Skjøtt-Larsen, 1999). At the end of the 80's and during the 90's a change took place. The previous relations were replaced by strategic partnership characterized by a high degree of information exchange (Skjøtt-Larsen, 1999). Examples of terminology describing these relationship forms are adversarial arm's-length and non-adversarial arm's-length (Cox, 2001b) or single and repeated transactions (Webster, 1992).

COLLABORATION

To collaborate is generally to work jointly or cooperate with someone who one is not immediately connected to. Cooperate in its turn means to act or work together with others for mutual benefit. Examples of these relationship forms are adversarial collaborative or non-adversarial collaborative (Cox, 2001b), partnership (Webster, 1992; Mentzer *et al.*, 2000) and supplier-producer collaboration (Cravens *et al.*, 1996).

INTEGRATION

Integration is basically the incorporation of two units into one unit. Integration is here defined as a relationship with mutual ownership between two organizations. The first reason for distinguishing between collaboration and integration is that in joint ownership, acquisition and so on, there is no longer an inter-organizational relationship between different organizations and therefore not a traditional supply chain collaboration. The second reason is based on the assumption that the level of control and the level of top-management involvement increases correspondingly to the level of ownership, and consequently, the

prerequisites for managing the supply chain are greatly enhanced. However, this does not necessary lead to effective cooperation. The business environment for companies in an integrated relation is more stable than for companies in a transactional or collaborative relation. Integration is therefore more comparable to a company group relationship than to a supply chain relationship. Examples of integrating relationships are vertical integration (Webster, 1992), acquisitions (Ellram, 1991), joint venture (Ellram, 1991), and complete ownership (Bengtsson *et al.*, 1998).

CHARACTERISTICS OF SUPPLY CHAIN INTERACTION

Some of the characteristics of collaboration are common with those of transaction and integration, for instance product and/or service exchange. Other characteristics such as long-term relation or mutual gain are common with integration but distinguish collaboration from transaction. A feature such as ownership then distinguishes integration from collaboration (and transaction). Two critical aspects of interaction are the extent, both in terms of the extension and time frame, and the content.

EXTENT

The opinion about the first dimension of extent, the extension of interactions, varies. According to Harland (1996) supply chain interaction concentrates on the level of the dyad or two party relationship in accordance to the system level definition. This is also supported by Mentzer *et al.* (2000) who claim that partnership is an inter-organizational entity developed between two independent organizations in a vertical relationship within a supply chain. Horvath (2001) on the other hand claims that a strategic supply chain management demands cooperation among all participants in the value chain. Simatupang and Sridharan (2005) take a mediate way and claim that supply chain collaboration often is defined as two or more chain members working together to create a competitive advantage through sharing information, making joint decisions, and sharing the benefits which result from greater profitability of satisfying end customer needs than acting alone.

The other dimension of extent is the time frame. A long-term approach to a relation will, for example, distinguish collaboration from transaction.

The motivation for focusing on only the dyadic relationship is that even if the supply chain concept embraces several companies, every single company has to treat each connection to another company as unique. As a result, supply chain interaction is comprised of a set of dyadic relations and each company is likely to participate in several different relations.

CONTENT

When the extent of interaction is determined, the interaction has to be filled with content,

i.e., what the companies do cooperate about and how. The most obvious content of interaction is the product or service exchange, since that is what we usually interpret into the flow between companies. The flow could also be constituted of financial exchange. Another content that characterizes higher levels of interaction, i.e. collaboration or integration, is the

sharing of information between companies (Simatupang and Sridharan, 2005). The importance of information sharing is emphasized by Forrester (1958) and Lee *et al.* (1997) through proving the spreading of the negative Forrester-effect or Bullwhip-effect, caused by information distortion, through a supply chain. To facilitate the creation and maintenance of higher levels of interaction, certain enablers should be present.

Factors enabling higher levels of Supply Chain Interaction

Mentzer (2001) defines supply chain collaboration enablers as common interests, openness, mutual help, clear expectations, leadership, co-operation, trust, benefit sharing, and technology. Worth noticing is that, without the other relational enablers in place, advanced technology means nothing. It is also important to have a trusting relationship between the supply chain members, where each member has mutual confidence in the other members' capabilities and actions (Sahay, 2003). Other enablers worth mentioning here are information sharing, decision synchronization and incentive alignment (Simatupang and Sridharan, 2005) but also agreement, mutual gain and common perception (Bititci *et al.*, 2004).

Information sharing could aid the decision makers' planning and control of operations. Decision synchronization comprises both the planning and the operational context. Synchronized planning decisions include selecting target markets, product assortments, customer service level, promotion, and forecast. Synchronized operation decisions incorporate shipping schedules and replenishment. Finally, incentive alignment refers to how and to what degree collaborative companies share costs, risks, and benefits (Simatupang and Sridharan, 2005).

To create successful supply chain interaction, each relation should be a conscious agreement between the two organizations. The agreement could be defined in a contract or by mutual trust. A collaborative relationship should also be a win-win situation for both parties concerned. Bititci *et al.* (2004) claim that both companies ought to have a common perception of the relation as a friendly collaboration, if not, one of the companies is using the other for its own purposes. Other authors, as Cox (2001b), on the other hand argue that a buyer-supplier relation must, at the most basic level, be inherently conflictual. This does not contradict that buyers and suppliers can cooperate, but rather that business relations must exist in a state of permanent tension since individuals and organizations primarily indulge in exchange relations in order to satisfy their desire for money. In the next chapter the factors that affect what level of interaction that is appropriate in different situations will be treated.

FACTORS AFFECTING SUPPLY CHAIN INTERACTION

There are several factors affecting the choice of interaction level. In some cases, pairs of factors are correlating to each other, for example a low level of trust might demand a highly specified contract. Different aspects of the factors will later, in the framework, correspond to different levels of interaction, i.e. a high level of product complexity and strategic importance might imply that a high level of interaction is appropriate to ensure that the demand can be met. In this chapter some of the factors, commonly known to affect the level of interaction, are presented.

Context

Even though it was concluded earlier that all interactions are constituted of dyadic relations, the context in which we cooperate will affect how we work together. Each company has to be aware of what consequences one decision has on its collaborators (Sahay, 2003). Hence, if the context is constituted of a single company, a chain of companies or a network, are of tremendous importance. This is the area where most supply chain articles fail to elucidate. For example, the article by Oliver and Webber (1982) is often referred to as the first supply chain article, even though it only treats the integration of internal business functions.

Trust

A successful relationship is characterised by mutual trust (Corbett *et al.*, 1999). Companies that trust each other generate profit, serve customers better, and are more adaptable. The nature of trust comprises dependability, faith, and fairness. However, trust is not only positive, it is also deceptive since companies tend to believe that associates they trust, trust them as well (Kumar, 1996; Sahay, 2003). Kumar (1996) further argue that successful relationships should be flexible, informal and based on trust instead of based on long and detailed contracts. The conclusion is that trust is stronger than fear (contract).

Power

When designing a supply chain and cooperating with other companies, one has to consider the other company's size, impact, and status. If the other company is larger in size, has greater impact, and higher status, it will have more power in that relation. With greater power comes the ability to force a weaker company to make decisions that is merely favourable for the powerful company. The effect of power in supply chains has in fact been pointed out by several authors (Butaney and Lawrence, 1988; Cox, 2001b, a; Watson, 2001; Cox *et al.*, 2004).

Complexity and Criticality

Both the product being manufactured and the process used to manufacture can have different levels of complexity and criticality. The impact of the product complexity on the supply chain or supply network was emphasized by Fisher (1997) even though the content of complexity was not fully covered. When extending the product complexity to cover also aspects of uniqueness and strategic importance, Lamming *et al.* (2000) approached product criticality. Criticality could also imply how important a specific component is for a certain product and will thereby affect the required delivery precision offered by the collaborators. The process complexity refers to the difficulty in performing the operations due to inter-linkages with other processes (Sahay, 2003). Process criticality, then, refers to the importance of the particular process to the overall supply chain (Sahay, 2003).

Need for control and flexibility

An increased need for control in the supply chain demands a higher level of collaboration or an integrating relationship. The need for flexibility on the other hand is supported by a lower level of collaboration or a transactional relation since these relations are more dynamic and more easily changed or terminated than a stable integrated relation (Bengtsson *et al.*, 1998).

Maturity

Increased supply chain interaction maturity leads to reduced uncertainty and improved business performance and is the best route to follow to achieve competitive advantage. The characteristics of process maturity are predictability, capability, control, effectiveness, and efficiency (Childerhouse *et al.*, 2003).

Time frame

The timeframe is the period of time when the relation should exist. This factor is traditionally viewed as an important differentiator since a long-term relation by definition is constituted of a high level of interaction. Today, with shorter time-to-market and shorter product life cycles, a short-term relation could be at least as collaborative or integrated as a long-term relation. A long-term contract will, quite obvious, exist during an extended time frame. Long term commitment is, together with mutual trust, the characteristics of a successful relationship according to Corbett *et al.* (1999).

Frequency of interaction

According to a study of 160 companies, the success of customer-supplier relationship is dependent on the frequency of interaction between the partners (Sahay, 2003). There is no general rule to decide *how* frequently they should interact, but a portfolio matrix with four involvement zones was identified by the study. The involvement zones are strategic-, outsourcing-, in-house-, and convenience involvement. Each zone proposes a different level of involvement in various activities.

Content

The content of interaction, discussed earlier, will also affect the appropriate level of interaction. For example; what is the substance of the interaction? What interchange are taking place? Does one company only buy standard products from its supplier or do they exchange information, develop new products together, and cooperate towards common goals?

Strategic intention

Given the effort involved in creating and sustaining collaborative or integrating relations, a company has to focus on the relations it considers most important in the long run (Corbett *et al.*, 1999). The importance of a relation is in its turn influenced by a number of aspects, for example the power of the buyer or supplier, the complexity and criticality of the product, the content level, and the time frame of the relation.

CONCLUSIONS AND DISCUSSION

A distinction between different levels and types of interaction was initially made. The level of interaction ranges from pure transactions to full integration and the related types are for example single transaction, partnership, and complete ownership.

Factors affecting supply chain interaction were identified as context, trust, power, complexity and criticality of product and process, need for control and flexibility, maturity and time frame of interaction, frequency of interacting, content, and strategic intention of the relation.

The aim of this article was to clarify the characteristics and terminology concerning supply chain interaction. One area elucidated was the extent of interaction. It was concluded that all interaction, irrespective of supply chain context, starts with a dyadic relation. Within the content of interaction some factors enabling higher levels of interaction were presented. These are the basic factors needed to be able to collaborate or integrate at all. However, the context, in which the interaction exists, also has an impact on the content of interaction. In a supply chain, where the interaction is composed of a set of dyadic relations, each company has to be aware of the consequences one decision has on its collaborators.

The results are solely based on theoretical studies. The literature within the area is however rather widespread concerning from what perspective the supply chain interaction is regarded. Few, if any, articles define the extent or context of supply chain collaboration or the content of collaboration. Furthermore, Croom *et al.* (2000) concluded, based on an extensive literature review that the supply chain literature is dominated by descriptive empirical studies and only 6 % of the articles concerns prescriptive theoretical studies. This paper will therefore contribute to the creation of consistent theory.

This was one step forward towards a future framework supporting decisions concerning appropriate interaction levels and types. The appropriate level and type of interaction for manufacturing and distributing a specific product is affected by a number of factors. In this paper the factors associated with interaction were presented. There are also several factors concerning the product characteristics and the order winners and order qualifiers for different markets that will influence the proper collaboration type. These factors will be identified and treated later on in this research project.

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PAPER 3

SUPPLY CHAIN INTERACTION – MARKET REQUIREMENTS AFFECTING THE LEVEL OF INTERACTION

Bäckstrand, J., and Säfsten, K., Supply Chain Interaction – Market Requirements affecting the Level of Interaction, *Proceedings from the 15th IPSERA – International Purchasing and Supply Education and Research Association Conference*, San Diego, USA, 2006

SUPPLY CHAIN INTERACTION - MARKET REQUIREMENTS AFFECTING THE LEVEL OF INTERACTION

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ABSTRACT

Despite the amount of research within the supply chain area, the question how companies should select the way they interact within the supply chain, to best support the products being manufactured and distributed is still left unanswered. In this paper a number of market requirements that will affect the appropriate level of interaction are identified and listed. The aim is to support the interaction level decision for, primarily, small and medium sized companies in order to increase their competitiveness.

Key words: Supply chain collaboration, supply chain interaction, market requirements, SMME

INTRODUCTION

With the growing globalization of the market, it has become increasingly important for all companies to improve their competitiveness. One way to increase the competitiveness is by interacting with other companies in the supply chain. The question is no longer whether to establish relationships with other companies or not, but rather how and with which companies (Cravens et al., 1996).

For many companies, particularly for small and medium sized manufacturing enterprises (SMMEs) that face an ever growing number of low-wage competitors, interaction could be their only means to compete on the market. To assure that the interaction supports and increases the ability to compete, it is crucial that the interaction, with both suppliers and customers, are designed in an appropriate way. The way companies interact should support the manufactured and distributed products competitive priorities without demanding excess workload or resources.

An essential question is then: what should affect the way companies interact? Should not the product that is being manufactured and distributed in a supply chain and the market it is competing on affect the design of the supply chain?

EARLIER RESEARCH

It has been concluded that there is a lack of research on the link between product characteristics, market requirements and supply chain design decisions (decisions regarding interaction level) (Bäckstrand and Sandgren, 2005). On the other hand, the research on linking product characteristics or market requirements with manufacturing process has produced several frameworks supporting this decision (Hayes and Wheelwright, 1984;

Miltenburg, 1995; Hill, 2000). A lot of literature also covers different manufacturing strategies to create business opportunities (e.g. Hayes and Wheelwright, 1979; Wheelwright and Hayes, 1985; Pagh and Cooper, 1998; Hill, 2000). For example, the model by Hayes and Wheelwright (1979) support the manufacturing process decision based on the product variety, volume, and uniqueness. Hill (2000) proposes a model for choosing manufacturing process to support business and market requirements. Furthermore, the areas of supply, purchasing, inventory and materials management, and distribution logistics are also thoroughly covered (Mourits and Evers, 1995; Van Weele, 1996; Silver *et al.*, 1998; e.g. Arnold and Chapman, 2001).

Traditionally, each of the above mentioned areas have, both in research and in application, been treated as individual departments with no or little communication in-between. This has led to, in most cases deep and thorough research on how to improve each area. Even though this research is highly accurate, it leads to sub-optimisation of the individual instead of optimisation of a greater whole.

Oliver and Webber (1982) described the importance of cooperation and communication between different departments within a factory or a company. They called this control of internal information and materials flow "supply chain management".

If the attention is shifted away from focusing only on one company, to instead adopt a more holistic view, where the company instead is a part of a supply chain context, there is another area of research available; the supply chain research (e.g. Cooper *et al.*, 1997; Chen and Paulraj, 2004). Within this research area, the previously mentioned sub-optimisation applies for individual companies within the supply chain instead of for individual departments within a company. According to supply chain research a global optimum can only be reached when all companies within a supply chain cooperate instead of focusing on their own good.

Hence there are many different, and sometimes contradicting, fields of research to cover in order to gain the strategic knowledge that can support supply chain design decisions. Unlike the large multi-site manufacturing companies, with extensive hierarchies of technical staff and management which can focus solely on development and implementation of manufacturing process or supply chain improvements, the smaller manufacturer does not have the luxury to dedicate staff to such improvement activities (Greatbanks et al., 1998).

An analogy can here be made to the statement by Barry and Hill (1992) that companies need of make different choices of process depending on market requirements; companies also have to make different choices of level of interaction depending on market requirements.

There is thus a need for a comprehensive framework for facilitating supply chain design decisions concerning interaction level. The prime objective for this framework is to improve the condition and increase the competitiveness for SMMEs.

OBJECTIVE AND METHOD

The aim of this research project is to develop a comprehensible and practical framework for use for primarily SMME companies in order to facilitate the process of selecting appropriate level of interacting in their supply chain. The first stage in creating this framework was the definition of interaction levels in Bäckstrand and Säfsten (2005). The level of interaction between two companies can range from a single, non repeated transaction to a full merge into one single organisation. Within this scale three different main levels of interaction were identified, namely transaction, collaboration, and integration. Briefly, transaction is the exchange or transfer of goods, services or funds. Collaboration is a deliberate cooperation for

mutual gain, and integration is here defined as a relationship with mutual ownership between two organisations.

The appropriate level of interaction for manufacturing and distributing a specific product is then assumed to be affected by a number of factors. The factors associated with the surrounding supply chain, that will affect the interaction were identified as context, trust, power, complexity and criticality of product and process, need for control and flexibility, maturity and time frame of interaction, frequency of interacting, content, and strategic intention of the relation (Bäckstrand and Säfsten, 2005). There are also several factors concerning the product characteristics and the product order winners and order qualifiers (market requirements) for different markets that will influence the proper interaction level.

The aim of this paper is to identify the market requirement factors that will affect the possible and appropriate levels of supply chain interaction for each of a company's supply and distribution relations. In subsequent publications, the factors associated with product characteristics will be identified and described.

The result presented in this paper is based on theoretical studies. The literature is rather widespread concerning from what perspective supply chain collaboration and supply chain interaction are regarded. The article selection is thus deliberately multi-disciplinary and includes literature covering business and manufacturing strategy, SMMEs, logistics, supply chain management, supply chain collaboration, competitive priorities etc., in order to identify the contrasting themes and antecedence of the field. This research considers the interaction level decision based on the product characteristics and market requirements of an existing product.

PROBLEM AREAS

SUPPLY CHAIN COLLABORATION

The importance of collaboration within supply chains has been pointed out by several authors (e.g. Christopher, 1998; Horvath, 2001; Sahay, 2003). Supply chain collaboration facilitates the cooperation of participating members along the supply chain in order to improve the overall performance (Bowersox, 1990). Examples of benefits from collaboration include revenue enhancements, cost reductions, and operational flexibility to cope with high demand uncertainties (Fisher, 1997; Lee et al., 1997; Simatupang and Sridharan, 2005). Both practitioners and academics are due to these potential benefits becoming more and more interested in supply chain collaboration (Corbett et al., 1999; Horvath, 2001).

But, there are some flaws to the supply chain collaboration literature. For example, what defines collaboration? (Mentzer, 2001) What is the content of collaboration? Should a company strive to evolve all its relations into collaborations? Are all the involved companies benefiting from the collaboration? How should the enhanced benefits from collaborating be divided among the participating companies?

SUPPLY CHAIN INTERACTION

The intention of the majority of previous supply chain collaboration research has been to propose measures of the degree to which a company interacts with its partners in a supply

chain, without considering what the content of the interaction actually is (Simatupang and Sridharan, 2005).

Thus, a distinction between interaction and collaboration has to be made. In this paper, the term *interaction* includes all forms of contact between companies. When the interaction is deliberate and cooperative, the term *collaboration* is used. This is consistent with the terminology developed in Bäckstrand and Säfsten (2005) i.e., the three main levels of interaction; transaction, collaboration, and integration.

The supply chain interaction, as referred to in this paper, is defined by the extent, content, and context dimensions. Bäckstrand and Säfsten (2005) concluded that all interactions, irrespective of supply chain context, starts with a dyadic relation. The context, in which the relation exists, also has an impact on the content of interaction. A supply chain is composed of a number of dyadic relations, where each company has to be aware of the consequences a decision has on the other companies it interacts with.

PREREQUISITES FOR SMMES

Whilst there is a substantial body of literature regarding the supply chain area, both in its theory and its application, the relevance of this literature to the smaller manufacturer is less clear. The majority of the literature in the supply chain area appears to have been written either from the perspective of the larger multi sight manufacturing company, or without concern of the size and circumstances of the company.

The size of a company and the adherent power in the supply chain has in fact been identified as factors that affect possible interaction levels (Bäckstrand and Säfsten, 2005).

The circumstances for a company depend greatly on its resources, and resources, particularly people, are generally in short supply in smaller manufacturing companies. There has been an increased awareness of that the prerequisites for small and medium sized companies are fundamentally different, both in terms of how they compete on the market and how they are able to assimilate research findings (Storey, 1994).

A distinction is here made between small and medium sized enterprises (SME), which can include all forms of small and medium sized business activity, and small and medium sized manufacturing enterprises (SMME), which focuses entirely on manufacturing organisations (Greatbanks and Boaden, 1998; Greatbanks et al., 1998; Säfsten and Winroth, 2002). This distinction is useful when examining manufacturing issues and has therefore been adopted within this research.

SUPPLY CHAIN DESIGN

Design decisions in a supply chain concerns both the physical, or geographical, layout of the supply chain and strategic decisions, such as determining interaction level, within the supply chain. In this research the focus will be on determining the appropriate interaction level.

The connection between supply chain design and product characteristics has in fact been discussed in Selldin (2005) but the aspect of interaction was then not treated. Also, in Fisher (1997), a model for choosing the right supply chain for two different types of products were proposed. The two identified types of supply chains were “the physically efficient chain” and “the market responsive chain”. This model was somewhat criticized and further developed by Lamming et al. (2000) but neither was additional types of supply chains identified, nor was it

investigated *how* companied should interact in order to achieve these "physically efficient" or "market responsive" supply chains.

This absence of research on the link between product characteristics, market requirements and supply chain design decisions was highlighted in Bäckstrand and Sandgren (2005).

The question *how* companies should interact in their supply chain in order to best support the product and market requirements for the products being manufactured and distributed is in fact still left unanswered.

MARKET REQUIREMENTS

Different market requirements can apply for the same product, depending on how the company chooses to compete on the market. There is thus a need to first identify relevant market requirements and then to elucidate the impact these market requirements should have on the level of interaction.

Consider for example a fairly simple product that most people have experience of – milk. This example is used as a pedagogical illustration, even though milk is a process product and not a manufactured product. The product characteristics for milk are easily agreed upon; it is clearly fluid and perishable. The market requirements on the other hand might differ greatly, depending on which market it is intended for.

If the purpose of buying milk is to get some milk in your coffee at work, the relevant requirements may be that the milk should be available in an appropriate volume at a store close to the office (shelf availability). The price could then be of less concern.

If the purpose of buying milk instead is to provide all the local schools with lunch milk, other market requirements will certainly apply. The milk should then be delivered at the right time to the right school in the right quantity and the quality of the milk must be guaranteed. The available suppliers will also compete with pricing. The market requirements could be maintained quality, delivery precision and price. This type of diverging market requirements can be found for most products that have more than one field of application or compete on more than one market.

COMPETITIVE PRIORITIES

Several authors have identified competitive priorities as a set of goals for manufacturing which are used to align the business strategy and market requirements with the manufacturing task (e.g. Leong et al., 1990; Rudberg, 2004). To identify the relevant market requirements, market aspects such as target segment, product life cycle phase, competition, and rules and regulations must be taken into consideration. These market aspects will affect which market requirements that will apply and consequently which competitive priorities that will be relevant.

The competitive priorities were initially identified as cost, quality, flexibility, and delivery (Skinner, 1969; Wheelwright, 1978; Fine and Hax, 1985; Miltenburg, 1995). In a literature review Leong et al. (1990) identified a consensus on a set of five competitive priorities where innovativeness also were included. These five competitive priorities have later been empirically supported by Ward et al. (1998).

To be able to select an appropriate level of interaction with each supplier or distributor for a product, these market requirements, or competitive priorities, must hence be taken into consideration.

The internal production process will henceforth be viewed as a black-box, where the right quantity is assumed to be produced at the right time with the right quality and where only the input and output i.e. supply and distribution can be influenced. Something that must be noted is that the market requirements of interest here might be different from those that apply when manufacturing the product. For example, the market requirements that can be supported by supply are those who can be affected before the product are manufactured. Likewise, the market requirements that can be affected by distributors are those that can be influenced when the end product is finished.

The competitive priority ***quality*** refers to product and service quality. Quality can, according to Garvin (1987), be viewed as consisting of eight dimensions: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality.

Supplier:

The supplier can influence the first seven quality dimensions. (Perceived quality is primarily a result of marketing (Corbett and Van Wassenhove, 1993)

Correct product quality will support all the competitive priorities; *quality, cost,* and *delivery precision/speed* since quality decreases scrap and the need for returns.

Distributor:

A distributor should maintain the product quality delivered from producing company.

A distributor can influence the perceived quality and the perceived service.

Should suppliers, when delivering poor quality, be supported to increase their quality or reprimanded and replaced? Likewise, should a company choose distributor based on the distributors present performance or their future potential?

The competitive priority ***cost*** refers to both the costs of the product (how much the manufacturing company have to pay for raw material and components) and the pricing of the product (how much the customer will have to pay for the end product).

Supplier:

The supplier can primarily influence the product costs and can thereby indirect influence the pricing.

Distributor:

A distributor can affect the product image and the target segment, and thereby the possible pricing, by for example either make the product available everywhere or making sure that the product is rare.

A distributor can, as was noted above, influence the perceived quality and the perceived service. This in turn will influence what level of pricing the customer accepts.

The strategy when choosing supplier based on cost is closely connected to the over all business strategy. Should the supplier with the lowest price or the supplier with the best overall solution be selected?

The competitive priority ***delivery performance*** can be viewed as comprising delivery dependability (reliability), delivery precision and delivery speed (e.g. Leong et al., 1990; Miltenburg, 1995).

Supplier

To be able to provide the customer with the finished products at the right time without carrying excess inventory, the suppliers also have to deliver with precision.

Distributor

The distributor need to be able to identify what the customer demands and also realize the difference between delivery speed (deliver as fast as possible) and delivery precision (deliver when agreed).

A crucial requirement for being able to achieve high delivery performance is enough capacity. This applies for the suppliers, in the own production and for the distributors. The question when selecting level of interaction could be; Do we want a higher level of interaction, with presumably only a few reliable suppliers and distributors, and hence relatively fixed capacity? Or, do we instead aim at a lower level of interaction where the number of possible suppliers, and thereby the possible capacity is nearly infinite, but less reliable?

The competitive priority ***flexibility*** is usually divided into product mix and volume flexibility (Leong et al., 1990). Gerwin (1987) includes five additional flexibility categories; changeover, modification, rerouting, material and sequencing flexibility.

Supplier

Suppliers can improve the flexibility by delivering capacity and/or material.

The company has to make a "make or buy" decision regarding how to source components and raw material. The decision is highly dependent on what the available suppliers offer.

Distributor

Flexibility in time is a common demand on distributors. Will the products be shipped when ready or must the shipments be scheduled in advance?

The distributor can enhance the flexibility perceived by the customer by, for example cross docking, coordinated transports, and re-routing.

Postponement strategies, where the customisation is carried out by the distributor, will also increase the flexibility (Pagh and Cooper, 1998).

What type of flexibility is needed from the supplier? Is the supplier included in the development process of a new product, or is the supplier selected after the product is designed, based on the product characteristics? Also, is flexibility needed from the distributor, and if so, what type?

The competitive priority ***innovativeness*** refers to the introduction of new products and processes. This is hence closely related to the product development process.

Supplier

An existing supplier can support innovativeness by presenting their own innovations or product enhancements to the company, by developing new products jointly with the company, by offering the component or production process that is needed, or by adapting their production to the new product invented by the company.

Distributor

The distributor can increase the over all innovativeness by new, innovative ways of introducing the product on the market. Examples of this could be third party-logistics, new packaging solutions, and added value closer to market by postponement.

If innovativeness is the most important competitive priority of all the market requirements, it will have a great impact on the level of interaction decision. Is a high level of interaction where for example pioneer work and classified information can be shared sought-after? Or is the innovation composed of standard components that can be sourced anywhere?

Order winners and order qualifiers

Order winners and order qualifiers refers to the criterions (usually within the competitive priorities) that are needed to win an order respectively to compete on the market at all (Hill, 2000). The order winning and qualifying criteria represent a way of describing a market in terms of required manufacturing capabilities (Berry and Hill, 1992; Rudberg, 2002). The order winners and order qualifiers evolves over time and different criterions applies at different stages of the product life cycle (Corbett and Van Wassenhove, 1993). Before trying to adapt the level of interaction in the supply chain to support *all* the competitive priorities, an analysis of the market is needed to identify what order winners and order qualifiers that apply for that specific market and customer segment.

CONCLUSIONS AND FUTURE RESEARCH

The contribution of this paper is threefold. First, it contributes to the creation of a more consistent supply chain terminology by throughout the paper refer to the three main levels of interaction, i.e. transaction, collaboration and integration, defined in Bäckstrand and Säfsten (2005). If these levels of interaction and their content, context and extent respectively, are referred to when discussing interactions in supply chains, a more consistent terminology will eventually be created.

Second, the lack of research on the link between product characteristics, market requirements and supply chain design decisions has been elucidated. Also, the negative implications for SMMEs due to that lacking link has been pointed out.

Third, the market requirements affecting the level of interaction were identified and described. There are also several factors concerning the product characteristics that have so far been ignored, that will influence the proper level of interaction. These factors will be identified and treated later on in this research project.

The market requirements factors together with the factors associated with product characteristics, the supply chain factors, and the identified levels of interaction (i.e. transaction, collaboration and integration) will create a basis for eventually constructing a comprehensive framework that can facilitate rational decisions concerning interaction level, primarily for SMMEs. These factors will be empirically tested to assure that they are valid for SMMEs and that no crucial factors have been omitted.

Furthermore, only six percent of supply chain literature concerns prescriptive theoretical studies, whereas the majority are descriptive empirical studies (Croom et al., 2000). This paper is therefore a complement to the existing research by providing a theoretically based, prescriptive overview of market requirements affecting the appropriate level of interaction.

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PAPER 4

LEVELS OF INTERACTION IN SUPPLY CHAINS

Bäckstrand, J., Levels of Interaction in Supply Chains, *Proceedings from PLAN's 8th Research and Application Conference on Logistics an Operations Management,* Trollhättan, Sweden, 2006

LEVELS OF INTERACTION IN SUPPLY CHAINS

Jenny Bäckstrand

ABSTRACT

To be able to durably retain the manufacturing industry, in Europe in general and in Sweden in specific, the many small and medium sized enterprises (SMEs) have to be competitive also on the global market. One way for companies to realize this ambition is to interact with suppliers and customers in different kinds of supply chains. The level of interaction between two companies can range from low to high level of interaction. To be able to enhance the competitiveness instead of requiring excess workload, the level of interaction has to be selected in an appropriate way.

The research on interaction between companies is often called supply chain collaboration and has lately attracted a lot of, at least academic, interest. The potential benefits from this research for SMEs are many, but the direct applicability is still limited. The existing supply chain collaboration research have so far mostly offered conceptual models that on a high abstraction or strategic level indicates how supply chains should be designed (e.g. Fisher, 1997). There are also no uniform terminology describing the relation between companies (Simatupang and Sridharan, 2005). To increase the applicability for SMEs, the research contribution has to become more concrete and homogeneous.

A basic prerequisite to enable companies to select an appropriate level of interaction within their supply chain is to elucidate and clarify the present use of terminology. This is one of the aims in this paper. In the dyadic relation between two companies, three different levels of interaction have been identified. These three level of interaction, how they are defined and the unit of analysis is also treated in this paper.

INTRODUCTION

Regardless of origin, size or trade, it has become increasingly important for all companies to improve their competitiveness. One way to increase the competitiveness is to interact with other companies in their supply chain. Particularly for small and medium sized manufacturing companies that face an ever growing number of low-wage competitors, interaction could be their only means to compete on the market. This interaction between companies is academically named supply chain collaboration.

The importance and impact of collaboration within supply chains has been pointed out by several authors (e.g. Christopher, 1998; Horvath, 2001; Sahay, 2003). According to Bowersox (1990) the over all performance is improved by supply chain collaboration since it facilitates the cooperation of participating members along the supply chain. Other examples of benefits from collaboration include revenue enhancements, cost reductions, and operational flexibility to cope with high demand uncertainties (Fisher, 1997; Lee *et al.*, 1997; Simatupang and Sridharan, 2005).

Both practitioners and academics are due to these potential benefits becoming more and more interested in supply chain collaboration (Corbett *et al.*, 1999; Horvath, 2001). How companies should interact, with both suppliers and customers, and what internal and external prerequisites that will affect the appropriate level of interaction are thus important areas to elucidate. This has been pointed out in previous publications (e.g. Bäckstrand and Säfsten, 2005, 2006).

But, there are also some other flaws or "white spots" regarding the supply chain collaboration literature, both in its theory and its application. Firstly, even though there is a substantial body of literature regarding supply chains and supply chain collaboration, the relevance of this literature to the smaller manufacturer is less clear. Secondly, there is vast terminology confusion. For example, what defines collaboration (Mentzer, 2001)? What is the content of collaboration? What is the extent of collaboration? What is the unit of analysis? Should a company strive to transform all its relations into collaborations?

OBJECTIVE AND METHOD

The aim of this paper is to elucidate and clarify the present use of supply chain collaboration terminology. The levels of interaction, how they are defined and the unit of analysis are also treated in this paper.

To increase the applicability for SMEs, the research contribution has to become more concrete and homogeneous. This paper does not claim to present a complete or concrete model, but it constitutes an important component in achieving the over all aim of this research project.

The over all aim of this research project is to develop a comprehensible and practical framework for use for primarily SME companies in order to facilitate the process of selecting appropriate level of interaction in their supply chain.

The first stage in creating this framework was the definition of interaction levels in Bäckstrand and Säfsten (2005).

The result presented in this paper is based on theoretical studies. The literature is rather widespread concerning from what perspective supply chain collaboration and supply chain interaction are regarded. The article selection is thus deliberately multi-disciplinary and includes literature covering business and manufacturing strategy, SMEs, logistics, supply chain management, supply chain collaboration, competitive priorities etc., in order to identify and capture the contrasting themes of the field.

RESEARCH RELEVANCE FOR SME'S?

The majority of the literature in the supply chain area appears to have been written either from the perspective of the larger multi sight manufacturing company, or without concern of the size and circumstances of the company.

Storey (1994) stated that the circumstances for a company depend greatly on its resources, and resources - particularly people are generally in short supply in smaller manufacturing companies. He concludes that there has been an increased awareness of that the prerequisites for small and medium sized companies are fundamentally different, both in terms of how they compete on the market and how they are able to assimilate research findings

This statement is supported by Greatbanks *et al.* (1998) that argue that unlike the large multi-site manufacturing companies, with extensive hierarchies of technical staff and management

which can focus solely on development and implementation of manufacturing processes or supply chain improvements, the smaller manufacturer does not have the ability to dedicate staff to such improvement activities.

In this paper a further distinction is made between small and medium sized enterprises (SME), which can include all forms business activity, and small and medium sized manufacturing enterprises (SMME), which focuses entirely on manufacturing organizations (Greatbanks and Boaden, 1998; Greatbanks *et al.*, 1998; Säfsten and Winroth, 2002). This distinction is useful when examining manufacturing issues and has therefore been adopted within this research.

CONFUSION IN TERMINOLOGY

The confusion in terminology can mainly be derived from two causes. Firstly, the inconsequent use of terminology makes any attempt to assimilate the existing supply chain collaboration research troublesome. Secondly, even if the author and the reader agree on the terminology use, they might not have the same interpretation of what is included in a specific phrase.

Use of terminology

In the existing supply chain collaboration research, many similar words are being used; see Table 1 for an example. This list merely constitutes a selection of all the terms used.

Table 1 Commonly used supply chain collaboration terms and their synonyms.

Term	Synonyms (example)
Collaboration	Association, partnership, alliance relationship, cooperation
Cooperation	Collaboration, support, help, mutual aid
Interaction	Contact, interface, relation, communication
Integration	Incorporation, assimilation
Alliance	Association, pact, treaty, coalition, union, grouping
Partnership	Joint venture
Relationship	Association, connection, affiliation, bond, liaison, link

In some publications these words are used to differentiate between different specific phenomenon and parts of the supply chain collaboration (e.g. Kahn and Mentzer, 1996). In other publications, these words are alternately used for the same phenomenon just to vary the language (e.g. Persson and Håkansson, 2006). In this research, the words *relation or relationship* are used in the wider sense, to indicate any link between two companies, regardless if the link is active or not. The term *interaction* is used when the relation is mutual and the companies have some kind of contact. *Collaboration* is here merely one level of interaction.

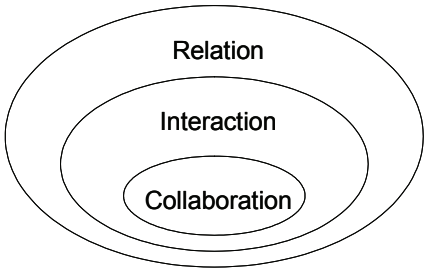

Figure 1 Definition of terminology use.

INTERPRETATION OF SUPPLY CHAIN COLLABORATION

EXTENT AND CONTEXT

The extent of relationships is basically divided into internal or external relations. External relations vary in number of participants from a dyadic relation between two companies to extensive networks with numerous participants. (Cooper *et al.*, 1997b)

Bäckstrand and Säfsten (2005) concluded that the extent of all relations, irrespective of supply chain context, starts with a dyadic relation. This research will consequently only treat one dyadic relation at a time. The relation could be with either a supplier or a customer. The relation will also only be viewed and analyzed from one of the companies' point-of-view; this is illustrated in Figure 2.

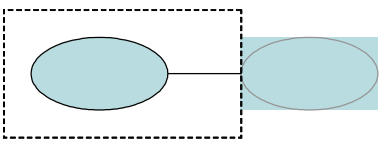

Figure 2 The dyadic relation from one company's point of view.

The first reason for this delimitation is that only each individual company can know what their expected outcome and the strategic intention of the relation is. The second reason is that the two companies will, most likely, have different approaches to the relation. This does not restrict the possibility to analyze the relation from both companies point-of-view, as long as the researcher is aware that the analyses have to be done separately.

The context, in which the relation exists, has an impact on the content of interaction. A supply chain is composed of a number of dyadic relations, where each company has to be aware of the consequences a decision has on the other companies it interacts with.

CONTENT

The content of the interaction will vary when the level of interaction varies. When the level of interaction is low, the transaction of goods and money is handled by the seller at one company and the buyer at the other company. This way of handling an interaction is traditionally referred to as "The bow-tie approach" (Cooper *et al.*, 1997a).

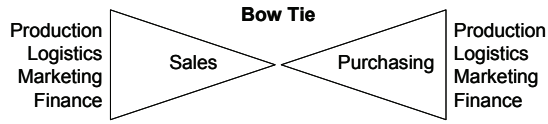

Figure 3 An illustration of the bow-tie approach, where most company functions are separated.

As the interaction level gets higher, the triangles that represent the two companies rotate; consequently each internal function gets closer to its corresponding function in the other company. The area of the surface where interaction is possible is thereby increased. The resulting relationship is referred to as "the diamond approach" (Cooper *et al.*, 1997a).

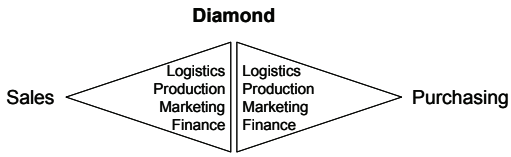

Figure 4 An illustration of the diamond approach where the companies can interact, function by function.

LEVEL OF INTERACTION

The intention of the majority of previous supply chain collaboration research has been to propose measures of the degree to which a company interacts with its partners in a supply chain, without considering what the content of the interaction actually is (Simatupang and Sridharan, 2005). One resulting problem is then that different units of analysis are put on the same scale. Examples of this can be found in Table 2 where, for instance exchange, contractual forms, time frame and ownership are put on the same scale.

Table 2 Different interpretations of interaction levels.

Author	What?	Low range	Level of Interaction					High range
Marshal (1923) Coase (1937)	Alternative forms of organizations	Market						Vertical integration
Blois (1972)	Intermediate forms of organizations				Vertical quasi-integration			Vertical integration
Ellram (1991)	Channel literature Organizational form		Discrete transactional relationship	Co-operative understanding	Long-term contracts	Ownership		
Ellram (1991)	Type of competitive relationship	Transaction	Short term Contract	Long term Contract	Joint venture	Equity interest		Acquisition
Webster (1992)	Range of marketing relationships	Transaction	Repeated transaction	Long-term relationship	Buyer-seller partnership	Strategic alliances	Network organizations	Vertical integration
Leavy (1994)	Buyer – supplier relationship approach		Traditional perspective-competitors	The JIT perspective – partners				
Harland (1996)	An intermediate type of relationship	Pure market	----	----	Supply chain management	----	----	Vertical integration
Harland (1996)	Partnership as type of relationship	Purchase order or spot market	Product life Partnership	Shared destiny Partnership	Minority shareholding Partnership	Strategic alliance Partnership	Joint venture	Acquisition
Lambert *et al.* (1996)	3 types of relationships	Arm' s length transactions	Type I Partnership	Type II Partnership	Type III Partnership	Joint venture		Vertical integration
Newman and Huang (2006)	4 levels of integration	No integration outside the functional silos	Functional effectiveness	Cross-functional effectiveness	Supplier/ customer effectiveness	Multi-tier effectiveness		Fully integrated supply chain

UNIT OF ANALYSIS

The unit of analysis, i.e. what we analyze and compare within a relation is connected to the content of interaction. For example, when the relationship becomes deeper or the level of interaction becomes higher, what in the relation has changed from before?

When conducting a literature review and comparing different levels of interaction, as in Table 2, one can read between the lines, even though it is not explicitly stated, that many of the content components will change. It might thus be hard to derive what the real reason for a change in relationship is due to. For instance, the relation will most likely evolve or transform over time. Is this relational transformation then due to the length of the relationship, the frequency of interaction, the adaptation of resources or due to the fact that people within the organizations have gotten to know each other?

In the underlying literature review the following units of analysis were easily identified; processes or activities, time frame, frequency of interaction, market drivers, strategic intention, contractual form and level of trust.

A higher level of interaction does require more integration of processes and activities according to Cagliano *et al.* (2004). This is also supported by Lambert *et al* (1996). The recent literature has been focused on the integration of activities and information flows. Two different areas of inter-organizational integrations have been defined: operational and technical integration. Operational refers to the integration of activities such as planning production delivery and quality. Technological refers to collaboration in designing and developing new products. (Cagliano *et al.*, 2004, p.153).

Time frame is used as a unit of analysis by Ellram (1991), Webster (1992), Lambert *et al.* (1996) and Harland (1996). They all assume that relationships will become deeper over time. Frequency of interaction is somewhat connected to the time frame of the relationship, and with the same assumption that the relation will become deeper with more opportunities to interact. This will however depend on the business area. In a business where the products have short life cycles, two companies might interact frequently under a short period of time, without any deeper relationship evolving.

Market drivers and type of economy is another way to differentiate between types of relationship, used by for example Leavy (1994) and Persson and Håkansson (2006). This is interlinked with the strategic intention of the interaction. Are the suppliers selected based on price or innovativeness?

Contracts and trust are in some sense each others opposites. With a low level of trust between companies the terms regulated in a contract is of immense importance. This is however not how contractual form is interpreted by most authors. Ellram (1991) for instance distinguish between long term and short term contracts i.e., the time frame point of view.

CONCLUSIONS AND FUTURE RESEARCH

The confusion in terminology within the supply chain collaboration area has been highlighted. The negative implications for SMMEs due to the lack of homogeneity have also been emphasized.

It seams like every author comes up with their own definition of the supply chain collaboration concept, and yet another definition is not sought after here. Compare for

example with the vast number of definitions that occurs in logistics research (Waters, 2003 p. 5; Christopher, 2005 p. 4) or supply chain management research (Oliver and Webber, 1982; Ellram, 1991; Lambert *et al.*, 1998; e.g. Christopher, 2005 p. 5).

This paper does not claim to present the panacea on how to interact with ones suppliers or customers, but does instead urge each author to clearly state the extent, context and content of the interaction they are describing.

Also, when measures are proposed to what extent two companies interact, it is important to define the unit of analysis, to avoid comparing different things on the same scale.

One thing that is important to keep in mind is that even though these scales of interaction levels range from a low level of interaction to higher levels, this does not imply that a higher level of interaction per se always is better. The issue for all companies is to find the appropriate level of interaction, for each relation.

The appropriate level of interaction for manufacturing and distributing a specific product is then assumed to be affected by a number of factors. These factors are, in this research, assumed to be distributed over three different aspects; the supply chain aspect, the product aspect and the market aspect.

The market requirements factors (Bäckstrand and Säfsten, 2006) together with the factors associated with product characteristics (to be dealt with in a forthcoming article), the supply chain factors (Bäckstrand and Säfsten, 2005), and the identified levels of interaction (i.e. transaction, collaboration and integration) will create a basis for eventually constructing a comprehensive framework that can facilitate rational decisions concerning interaction level, primarily for SMMEs. These factors will be empirically tested to assure that they are valid for SMMEs and that no crucial factors have been omitted.

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