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Information sharing in R&D collaboration – Context-dependency and means of governance

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ABSTRACT

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This study examines the context-dependency of information sharing by evaluating the factors that arise in the business environment and can have an influence on the nature of information sharing, with the means of governing information sharing being highlighted. The study has been conducted as a single case study with three Sub-Cases in the Finnish telecommunication sector.

The work follows the supply management approach. The theoretical background presents the nature of information sharing as a supply networking activity, describes the challenges and risks, brings managerial insights to this context, and results in an a priori framework in which the context-dependency of networking activities can be studied. The findings suggest that there is a need to combine different levels of network research, namely networks, supply chains, dyadic relationships, and companies. Moreover, the framework includes the task and product characteristics. In the end of the theoretical part the a priori framework was utilized when reviewing the existing studies on the context-dependency of information sharing and when categorizing the identified factors according to the elements in the framework.

The empirical research supplements the current understanding of the context-dependency of information sharing in the context of R&D collaboration. The data consists of the focal firm's perspectives in three R&D programs with three main R&D suppliers. The results indicate that the most influential factors affecting information sharing stem from the nature of the development task given to the supplier. The maturity of the technology, especially in the specific product area, and the capabilities of the suppliers were also regarded significant in the sharing of information. The contextual factors were analyzed in terms of information sharing activity, which in this study was assessed by its content, media and style in different phases of the R&D programs. The results furthermore point out some means that could help in governing information sharing. These means were positioned onto the right coordination level, and supply management and R&D program management levels were distinguished. Finally, an important finding is that despite the challenging

business environment, smooth information sharing in R&D collaboration can be guaranteed by appropriate means of governance.

Keywords: Information sharing, R&D collaboration, context-dependency, telecommunication business

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Lappeenranta, October 17th, 2006

Heli Sissonen

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ABBREVIATIONS

DC	Dynamic Capabilities
ICT	Information and Communication Technology
IMP	Industrial Marketing and Purchasing
IP	Internet Protocol
IT	Information Technology
NDA	Non-Disclosure Agreement
NPD	New Product Development
R&D	Research and Development
RBV	Resource-Based View
SCM	Supply Chain Management
TCE	Transaction Cost Economics

1 INTRODUCTION TO THE STUDY

This study aims at revealing the context-dependency of information sharing in R&D (research and development) collaboration. To be more precise, information sharing is regarded as an essential networking activity and a tool to manage and coordinate the collaboration taking place in the field of R&D. It is suggested that context-dependency is an important element in responding to this managerial challenge: activities and management practices are useful only in the right contexts.

R&D collaboration is analyzed here on a dyadic level, and the analysis concentrates on the information sharing activities between the focal company and their R&D suppliers. The purpose of this type of collaboration is to develop new products for customers operating in the telecommunication sector.

This introductory chapter gives an overview of the background to the study and outlines the purpose of the study as well as the research questions, next presenting the research framework briefly. Then, the main concepts of the study are explained. Finally, the empirical research context is introduced, and the chapter ends with the presentation of the structure of the study.

1.1 Background to the study

Tightening competition and ever-increased efficiency requirements force companies to concentrate on the functions they know best and outsource other functions, or buy them from company networks (Harland, Lamming & Cousins 1999). In this era of networking and collaborative relationships, the management and coordination of these relationships and networks as well as the activities and resources between them become a key issue to gain competitive advantage and operational efficiency. Nevertheless, there is no doubt how challenging it is to manage different types of

relationships and networks. As a consequence of separation in distance, language and the culture of organization members, communication and cooperation between diverse participants have been recognized as crucial elements to maintain organizational stability and adaptation to change (Peng & Littlejohn 2001).

Many studies in partnership research have shown how critical *communication and information sharing* between partners is (see e.g. Ellram & Edis 1996; Mohr & Spekman 1994, 1996; Virolainen 1998). In fact, because of its importance in the business relationships, communication and information sharing have received much attention in the field of Purchasing and Supply Management as a critical *partnership success factor*. Harland & Knight (2001, 8) contend that to be successfully managed, network level decisions need a close consideration about structural decisions with external partners, confirmation and establishment of interorganizational transparency and openness, and availability of quality data. The organizational setting also requires widely shared information and high quality communication, namely, expertise in communication.

The importance of information sharing has also been recognized in the *R&D* research (see e.g. Allen 1977; McGinnis 1999; Wynstra, Axelsson & Van Weele 2000). The *R&D phase* creates specific challenges in information sharing, because the content of information is not always locked at the beginning of the development project, and "*even the customers cannot specify exactly what they want*" (Case Company Material 2005a). This means that the development process must be kept open for customer feedback and other change requests coming from other functions or development projects within the focal company. This may result in changes in the requirements and subsequent modifications in the product. (Segelod & Jordan 2004, 250) Another feature of the new product development is the *complexity of information* to be shared: future products consist of many elements, which must match each other, and they include a lot of detailed product information (codes, specifications, product features, etc) (Case Company Material 2004).

The study has been implemented in the Finnish telecommunication sector, and in fact, industry-specific factors emphasize the need for studying coordination of supply networks for several reason, as Agrell, Lindroth & Norrman (2004) have noticed. Firstly, companies are increasingly working against the clock, and the business logic has changed. Secondly, the increased use of outsourcing of manufacturing and R&D to suppliers, shorter product life cycles, and compressed time-to-market have induced changes in coordination mechanisms. Furthermore, because of the demand uncertainty in both the level and timing, the roles and responsibilities in the supply chain are changing, leading to unclear interfaces. There is also strong growth and consolidation among suppliers, leading to shifts in the power balance (Agrell et al. 2004).

All the reasons listed above make both the R&D collaboration and information sharing challenging in the telecommunication sector. In fact, the model of Ragatz, Handfield & Petersen (2002, 392) posits that *technological uncertainty* impacts the significance of integrative strategies. In other words, high-risk/uncertain technology needs place a greater premium on the tools and techniques of information exchange. These factors lead to an emphasis on the significance of efficient coordination mechanisms, where smooth information sharing plays a great role. Mohr (1996) is in line with these findings, when contending that the management and control of information is especially crucial for those firms that face an environment characterized by frequent innovation, a high priority on research and development, and where information is time-sensitive. High-technology environments tend to be information intensive, in which both the amount of information is large and the speed of information transmission is fast (Mohr 1996 citing Glazer 1991).

Consequently, when taking into account the challenging fields of collaboration, nature of R&D and the complexity and sensitivity of information, the question of managing information in the right way becomes a key issue in successful R&D collaboration. In this study context-dependency is regarded as an important part in managing the information sharing activity in a network.

1.2 Research objectives

This study aims at analyzing the complex, challenging field of information sharing specific to buyer–supplier relationships in R&D collaboration. The research purpose is formulated in the following way:

To clarify the context-dependency and means of governance of information sharing in R&D collaboration

The context-dependency of information sharing refers to those factors that may influence the ways in which the focal company shares information with their R&D suppliers. Additionally, it is important to recognize *how* these factors may influence information sharing, and *how* the focal company can manage information sharing under these circumstances. Context-dependency is taken as a key issue in information sharing, since "information and knowledge are only useful in specific situations" (Lueg 2001). It is traditionally accepted that a company has to understand their business environment and adapt their operations to that, but it is obvious that when collaborating with other companies an understanding of this context becomes more complicated. Cox (1997) also emphasizes the significance of understanding context-dependency. He states that it is important to comprehend the appropriateness of the suggested solutions through two types of analysis: first of all, to understand why and in which circumstances certain models or tools and processes are applied, and secondly, also to consider which are the appropriate tools to be used in the first place. In other words, "it is essential that practitioners recognise that what is appropriate in one context may be inappropriate in another" (Cox 1999, 171).

Harland et al. (2001) and Lamming et al. (2000) provide arguments for considering and analyzing the network as an *activity* environment. In fact, it is important task for researchers in the field of supply chain management to try to classify supply networks into types that share important characteristics; thereby identifying practices of

networking that are appropriate for managing in particular circumstance. Later on, Harland et al. (2004) point out the fact that "little guidance has been provided as to how supply networks of different types facing different business situations can be created and operated effectively." Section 3.3.1 continues this discussion and thoroughly introduces the concept of context-dependency.

1.2.1 Research questions

In order to clarify the research purpose, the first research question can be posed.

What is the context-dependency of information sharing in R&D collaboration?

This first research question is initially approached in the theoretical part (Chapters 3 and 4), when considering information sharing as a networking activity (Chapter 3) and when considering the different levels and elements in which context-dependency can be studied in the field of Supply Management (Chapter 4). Therefore, one objective of this study is to increase our understanding of information sharing as a networking activity, and to provide a framework to study context-dependency of networking activities purely from the theoretical point of view. Chapter 4 will result in a literature review of the context-dependency of information sharing.

This understanding will be elaborated in the empirical part, when examining if there are *other factors influencing information sharing that stem from the R&D collaboration context.* R&D activities differ greatly from the manufacturing process, and suppliers differ in the relationship nature, history, and importance, among other things. R&D suppliers in the R&D programs that develop complex products in the telecommunication sector form the basis for analyzing the context-dependency of

information sharing in this study. The R&D suppliers will be further classified according to the capabilities[1] required in completing the R&D task.

In terms of evaluating information sharing during R&D collaboration, it is important to identify the business premises that lead companies to pursue information sharing with their partners. This covers the evaluation of motives and risks in information sharing: why a company wants to share confidential, sensitive product and/or business information with their suppliers, and what kinds of risks relate to the sharing of information? This type of analysis makes it easier to understand the nature of information sharing and means of governance. It is also relevant to consider, in which way the context-dependency becomes visible. Since the current research clearly recognizes the importance of information sharing and how inherently extensive information sharing and communication are part of the strategic supplier relationships, it becomes interesting to examine more precisely *how the contextual factors influence the content, media, and style of information sharing.*

In the second phase, the study aims to answer the question of how the focal company can respond to the context-dependency of information sharing. Now it becomes possible to find out the means that are useful in the managing of information sharing, and the second main research question is thus formed:

Which means of governance are highlighted as a consequence of the context-dependency of information sharing?

When striving towards the governance of information sharing, the evaluation of the success factors applied in R&D collaboration become important. In the context of real-life employees often learn by doing and learning is accumulated only after completing the development task. Therefore, it would also be fruitful to find out those

[1] The competence perspective leads to the considerations of the resource-based theory introduced by Penrose (1958), and further developed, e.g., by Barney (1991). The competence perspective gained popularity in 1990, when Prahalad & Hamel (1990) introduced the concept of “core competence.”

lessons learned that are critical in the governance of information sharing. These means are analyzed in the light of context-dependency, expressly, against the circumstances that were found the most challenging and influential in information sharing. Furthermore, in addition to identifying such practices, it is interesting to consider the role of supply management in this. Therefore, the management practices are placed on the right level in terms of the coordinative unit. Practically this means separating the means of governance on the supplier management level which considers the collaboration issues in general, and secondly on the level of R&D program management, which is responsible for the management of the operative work taking place in the R&D programs.

1.2.2 Research framework

In this study the context-dependency of information sharing is explored with *an approach on the network research* in the field of Supply Management. Actually this study has its roots in three broad research streams: Supply Management, R&D Management, and Information Sharing. In order to avoid the overwhelming literature reviews, the starting point has been in the supply management literature, since it looks at the core of the buyer–supplier relationship, and provides insights into how networks and relationships can be analyzed. It also provides instruments by which to *manage* these relationships. Additionally, the supply management literature recognizes information sharing (or processing, as expressed by Johnsen et al. 2000) as a networking activity. The theoretical background and reasoning for the study is presented through the theories of Dynamic Capabilities, Resource-Based View of the firm, and Transaction Cost Economics. The following figure clarifies the interrelations between the different concepts of the study, and the theoretical background and relating research streams are marked in *italics*.

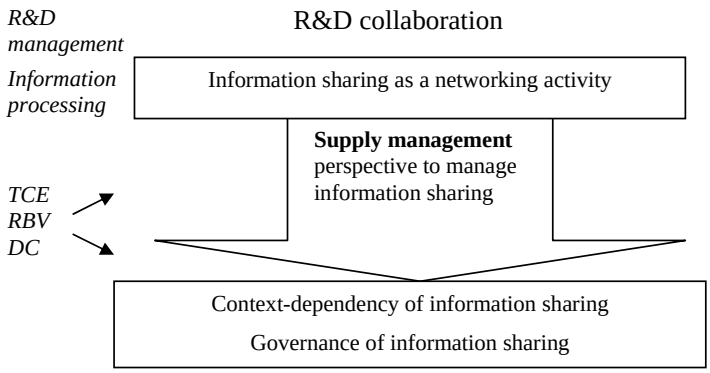

Figure 1. Key research areas

The starting point in the management approach is to focus on understanding and managing the context-dependency. Some of the practices and success factors found useful in the managing of information sharing and collaboration in general are presented in order to increase the relevance of context-dependency, but otherwise this study will not tackle the broad range of issues required in the management studies. This leads to a couple of significant limitations, and for example the decision-making procedures, organizational issues, and supplier strategies will not be considered in this study. Also, the theoretical frame is used mainly as a background to describe the importance of understanding the capability perspective (Dynamic Capabilities) and information as a resource (Resource-Based View of the firm). Transaction Cost Economics is related both to the context-dependency (features of transactions) and to revealing other restrictions in the governance mechanism (the bounded reality and opportunism).

The review of the literature (see e.g. the literature review provided by Huang, Lau & Mak 2003) shows that the current understanding of information sharing in the supply management literature is largely concerned with the operational information sharing, gaining efficiency through the usage of information technology. As an example, numerous studies on the usage of information technology are provided e.g. by Baker

(2000), Curry & Stancich (2000), Hong (2002), Larson & Kulchitsky (2000), Mirani, Moore & Weber (2001), and Ruppel & Harrington (2001), whereas the implications of the use of IT have been studied by Alshawi (2001), Baraldi (2001), Kumar & Palvia (2001), Morrell & Ezingeard (2002), and Motwani, Madan & Gunasekaran (2000). Another notion is that information sharing is for the most part considered as a success factor of a partnership, or an enabling factor in the R&D, as is reported by Leenders, van Engelen & Kratzer (2003) and Wynstra et al. (2000).

Moreover, previous studies have proved the connection between information sharing and the product complexity on one hand (e.g., Lamming et al. 2000), and between information sharing and business relationships on the other (e.g. Bensaou 1999; Ellram 1991). The assumption is that the complex product and the strategic nature of the business relationship guarantee a high level of information sharing. It makes the present study more fruitful, since the selection of the Sub-Cases for this study is based on the criteria of a complex product and collaborative relationship. Yet their impacts on the governance of information sharing, as well as the impacts on other influential, context-dependent factors provide an interesting research issue for this study. As pointed out by Lamming et al. (2000, 679), “There is little guidance for firms addressing specific supply-related problems such as choosing the right type of supply network appropriate for particular circumstances or how best to employ network technologies to enable the effective flow of supplies from raw material to end customers.”

The R&D-specific literature has been perused in order to better understand the special features arising from the R&D context, with the information-processing view gaining the least attention in order to avoid a totally new perspective to look at the research problem. Still, some basic concepts and the rationale for the theoretical background of information sharing have been found useful in this study.

1.3 Key concepts of the study

The study is built of two main themes, namely, information sharing and R&D collaboration. However, a wide set of concepts relating to these themes run through the study, and these focal concepts are summarized in the table below.

Table 1. The key concepts of the study

Concept	Definition
Information	Information is regarded as a resource that the supplier requires during R&D collaboration in order to be able to complete the desired tasks.
Content of information	Technical product information (specifications, standards), program information (schedules, plans), and strategic information (business strategies, business trends). The sharing of marketing (demand data), logistics (inventories) and financial data (product calculations etc) is out of the scope of this study.
Information sharing	Information sharing is regarded as formal, one-way action from the focal company to the supplier. Information sharing is a general term that is used throughout the study in order to retain the similarity when using comments.
Interaction	Information sharing is regarded as one form of interaction between the focal company and the suppliers. Interaction, when referring to two-way action, is used as a synonym for information sharing especially when meaning a general action in collaboration. The term *interaction* is used to a larger extent in the theoretical part of the study.
Communication	The word communication is widely used to refer to the interaction process between two parties, and like Halinen (1997, 189) explains: "communication refers to both social and information exchange." That is, communication includes a face-to-face contact, telephone conversation, or other synchronous medium where social interaction cannot be excluded.
Medium/media of information sharing	The means by which information is shared or communicated.
Style of information sharing	Features that characterize the nature of information sharing. It is evaluated through qualitative and quantitative measures.
Episode in the R&D program	A stage or phase in a time frame when R&D collaboration takes place. In this study the R&D program is divided into three episodes: beginning, middle, and end (see also R&D phase).
Context-dependency	Interactions and practices take place in specific situations considering all the related factors: context-dependency means something (here information sharing) that is determined by a set of interrelated conditions (here R&D collaboration)
Research and Development (R&D)	R&D refers to the "standard research and development activity devoted to increasing scientific or technical knowledge and the application of that knowledge to the creation of new and improved products and processes." (Hagedoorn 2002, 477). This study uses the R&D concept as a separation of the new product development (see the concept of NPD).
R&D phase	R&D phase consists of five sequential phases starting from the concept development, followed by system level design, detail design, testing and refinement, and product ramp-up. (Suomala & Jokioinen 2003, citing Ulrich

	& Eppinger 1995). For the purpose of this study, the R&D phase is divided into three parts: the beginning, middle, and the end (see also the episodes).
New product development (NPD)	NPD is an essential part of the R&D function (Suomala & Jokioinen 2003), although NPD can also be understood as a broader concept: According to Hart & Baker (1994), the NPD process is a series of interdependent and frequently overlapping activities which transform an idea into a prototype and on to a marketable product. In this study NPD is mostly used in the theoretical part when reviewing the past literature generated in the field.
Supply network	According to Harland et al. (2001, 22), "supply networks are nested within wider interorganization networks and consists of interconnected entities whose primary purpose is the procurement, use, and transformation of resources to provide packages of goods and services." Furthermore, "supply networks encompass the mess and complexity of networks involving lateral links, reverse loops, and two-way exchanges, and include a broad, strategic view of resource acquisition, development, management, and transformation." (Harland et al. 2001, 22)
Networking activity	Johnsen et al. (1999) define networking "as a transformation process of 'independent' actors and resources into a more closely knit configuration of a supply network." Networking activities, on the other hand, are "concerned with the bonding of actors and the tying of resources" (Johnsen et al. 1999). In this study information sharing is regarded as a networking activity.
R&D program	R&D program is a term used for a large R&D project. The program consists of several projects and sub projects, which can be either R&D or other projects (like quality and documentation projects).
R&D collaboration	R&D collaboration is a term used for subcontracting, outsourcing, and other type of cooperation which involves the focal company and such R&D suppliers that have a great role in developing the end product. Intense and strategic cooperation is called collaboration. In each program there is one main R&D supplier, but additionally the network-view forced to lay additional emphasis also on the other players in the network.
Focal company	The Case Company, also the buying company. The primary aspect is to consider only one of their Business Areas. The Business Area is divided into three business units, where the R&D programs are located.
R&D supplier	One of the main suppliers participating in the R&D program. There are three suppliers involved in the study, one in each Sub-Case.
Governance of information sharing	Governance[2] of information sharing was chosen as a concept to refer to the holistic perspective of managing information sharing. It takes into account the required management practices in the supply management, and combines those with the context-dependency of information sharing.

The concepts used in this study are not very coherent in the literature. Especially terms like *information*, *information sharing* and *communication* are conceptualized in

[2] Originally the term *governance mechanism* refers to the "formal contractual structures used to organize the partnerships" (Gulati 1998, 302), which is divided into markets, hierarchies and networks that exist in between. Basically the TCE (transaction cost economics) theory identifies the critical dimensions for characterizing transactions, describes the main governance structures of transactions, and indicates how and why transactions can be matched with institutions in a discriminating way (Williamson 1975). In this study the governance mechanism is not handled as such, because the starting point was to focus on collaborative relationship, where the choice on behalf of the governance mechanism has already been made.

different ways depending on the author, and they overlap in their meanings. Since information sharing is the main concept of the study, in Chapter 3 the concept of information sharing and related terms will be examined in more detail.

1.4 Origins of the study

This study is a consequence of the *results of the research project*[3] conducted in the Case Company of this study and some other companies in the Finnish ICT/telecommunication sector. As will be explained, this project has served as a starting point for the present study both in terms of the theoretical background and insights (context-dependency), and in terms of the empirical research context. The research project will be introduced rather carefully because it had a significant role in increasing my preunderstanding of the phenomenon studied here.

According to Gummesson (2000, 57), researchers should award more consideration to the significance of this so-called *preunderstanding* when choosing the scientific approach and methods. Gummesson defines preunderstanding as things such as people's knowledge, insights, and experience before they engage in a research program.

The following figure illustrates the focusing of the research topic and the empirical case in this wide research context. The topic was developed and sharpened from the research project as of 2001 until the year 2005, when the study was refined and the interviews were conducted.

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[3] The project "Information Technology in Business Relationships" was conducted in 2001–2003 in cooperation with the Lappeenranta University of Technology/Technology Business Research Center, University of Jyväskylä and Timo Kivistö Consulting Oy, as well as with companies operating in the information and communication technology industry. The main financing organization of the project was the Finnish Funding Agency for Technology and Innovation.

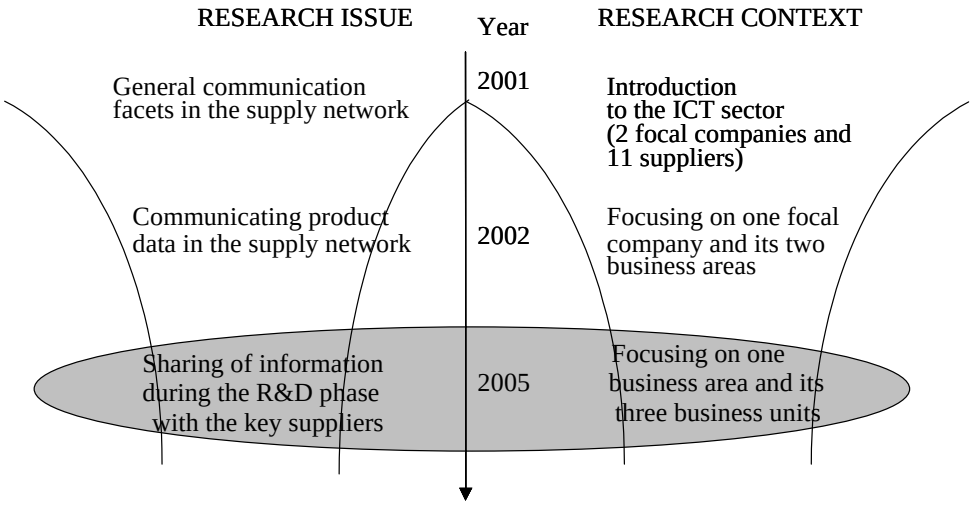

Figure 2. Focusing the research during the research process

The purpose of the research project was originally to study the management of supply networks from the communication perspective on one hand, and the use and implementation of information systems on the other. During the first year of the project I gained an understanding of the general communication features: the media in information exchange, and its facets (frequency, directionality, adequacy), as well as the content of communication in two ICT supply networks. The study was conducted as an Internet survey with 13 companies (two focal companies and their 1st to 3rd tier suppliers), and 82 respondents gave an overview of the general communication linkages between the companies in each supply chain studied (four supply chains in the supply network of one focal company and one supply chain of another one's).

In 2002 the project researchers were introduced to one specific form of information sharing: sharing of product data during the delivery operations in one of the project's case companies (the Case Company of the present study). Performing 32 semi-

structured interviews in June–October 2002 in the Case Company (in two of their Business Areas) and in four of their suppliers revealed, among other things, a couple of fundamental factors when implementing information systems and new inter-company procedures within the supply network. The most important notion was that the management of product data was not only about managing the operational information flows, but also about tackling the issues of ICT business and its characteristics, the sourcing strategy and partner management, and above all, strategic issues within information sharing, like the governance of information. The interviewees also discussed about the roles of product programs (the R&D projects) as a source of product data. It was concluded that there are several challenges in product information management already in the product program phase. For example, "the early involvement of the sourcing organization and suppliers will become more important in the future but that at the moment it includes uncertainties such as information security and technology leaks" (Huhtinen et al. 2003, 72).

The results of the research project exposed the challenging field of information sharing in the supply network. The importance of product programs in providing product information is also critical, as well as the roles of the sourcing organization and supply management.

The exploratory research conducted in 2002 also revealed some different views and expectations of the communication platform in two independent Business Areas. The context-dependency of information sharing became evident during the interviews, even though the issue was not raised in the questions: based on different types of products and production processes, the structure of the supply networks and hence the management practices of the suppliers were different between the Business Areas. Consequently, the drivers for implementing a common communication platform for managing product data were also inconsistent between the Business Areas. As a result *it became interesting to find out in more detail which organizational (involving suppliers) factors may have an influence on the sharing of information*. These

findings provided assurance to study this context-dependency of information sharing more in depth.

Based on those many challenges of sharing information during the manufacturing process, the following question was raised: “What is information sharing like in the earlier phases of buyer–supplier collaboration, where information might be more unspecified, more sensitive, and secure in its nature?” The increased risk of sharing information in the early phases of R&D highlights the need for evaluating the drivers and objectives to share information, and these drivers definitely differ from those identified in the manufacturing process.

This exploratory research project focused only on one way in which to govern the sharing of information in the supply network. The research focused on a certain extranet solution to be used with the selected suppliers. However, after identifying the many elements that have an influence on information sharing, *the study of the governance mode without any pre-assumptions (e.g., a generic database) gained the research interest*.

Moreover, an understanding of the telecommunication business and its trends and challenges as well as the Case Company’s overall business logic when collaborating with suppliers proved to be useful when performing the interviews in 2005: through this preunderstanding it was easier to create a clear picture of the collaboration in the Case Company, with these prior experiences affecting the implementation of this study. All in all, the research project generated an understanding of how complicated and large an issue information sharing is in Supply Management, and it became intriguing to study the phenomenon more deeply. Although none of the empirical data stemming from the project will be presented in this study, its role is regarded as an important element in the whole research process. This issue will be returned to in Section 2.2, when presenting the research strategy of the study, and its abductive research approach.

1.5 Structure of the study

This chapter has introduced the background and purpose of the thesis as well as the research questions with an illustration of the research framework. Also, the main concepts of the study have been explained, and the origins of the empirical research have been clarified. Finally, the chapter concludes with an outline of the structure of the study (see Figure 3).

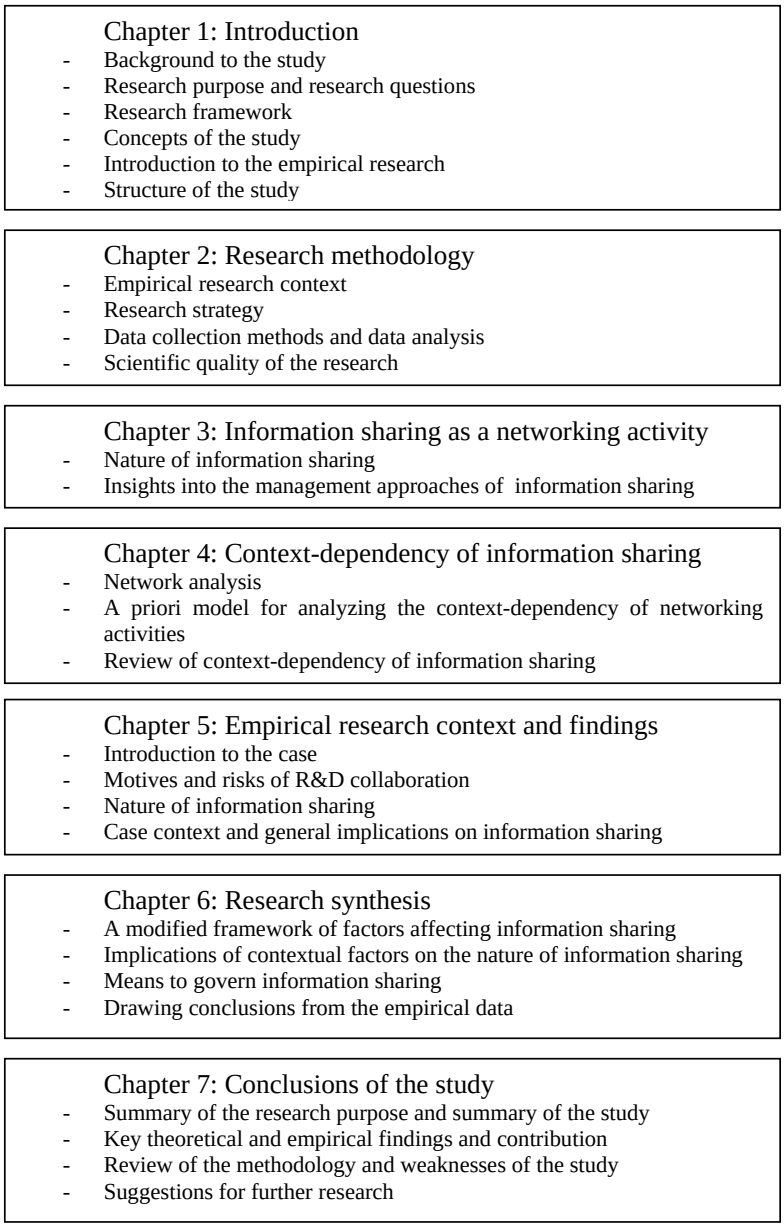

Figure 3. Structure of the study

The second chapter presents the research methodology, including the empirical research context and selection of the case and the Sub-Cases, considerations on research strategy, data collection methods, and evaluation of the research quality.

The third chapter concentrates on information sharing as a networking activity. The chapter first introduces a conceptual analysis of information and the related concepts. The nature of information sharing will be illustrated by presenting the facets of information sharing, namely, content, media, and style. Also, the main benefits, challenges and risks that are normally combined with information sharing in the network are introduced. The chapter ends in describing managerial challenges arisen in the sharing of information and collaboration in general. This includes the theoretical standpoints as well as an introduction to the supply management perspective in information sharing.

The fourth chapter is built on revealing the context-dependency of information sharing. First, an introduction to the general network analysis takes place. After that an a priori framework for studying the context-dependency of networking activities is proposed, followed by a literature review on the context-dependency of information sharing which is done by utilizing the framework just generated.

The fifth chapter introduces the results derived from the case study. This chapter is partly descriptive in its nature, and partly interpretative especially when revealing the relation between the nature of information sharing and the surrounding business environment. An introduction to the case, as well as motives and risks in R&D collaboration are first revealed, so that the reader gets familiar with the case context and challenges that the Case Company faces in today's business. Then, the elements of interaction as they appear in the a priori framework are presented in the case context: the nature of information sharing and the factors arising in the case environment. Finally, the success factors in information sharing and in R&D collaboration are presented.

The sixth chapter provides the research synthesis with a closer analysis of the context-dependency of information sharing with theoretical insights, and additionally, these views are complemented by highlighting such means of governance that could be regarded of importance due to the context-dependency. In the end of this chapter it is discussed how to draw conclusions from the empirical data and what kind of challenges are relating to the analysis.

Finally, the conclusions of the study summarize the main findings and contribution of the study. The scientific quality and the main weaknesses will also be evaluated, and some ideas for further research will be proposed.

2 RESEARCH METHODOLOGY

This chapter presents the empirical research context and gives an overview of the research strategy, data collection methods, and evaluation of the research quality.

2.1 Empirical research context

This study is a qualitative, mainly descriptive case study in its nature, where the empirical evidence has been collected in a Finnish ICT company. Palmberg & Martikainen (2003, 1) contend the following when arguing for using the ICT sector as a case industry: ”The limitation of the ICT sector is motivated by the strong international position that Finland has had in this sector since the mid 1990s. The ICT sector is also especially interesting from the viewpoint of strategic R&D alliances due to the systematic nature of the innovation.” Moreover, “digitalization of networks and the emergence of the Internet are blurring technology and industry boundaries, deconstructing value chains and reshaping business models” (Paija, Rönkkö & Steinbock 2001). These views provide arguments for why to conduct the study in the Finnish ICT sector.

Selection of the Case Company

The research context was determined to be the ICT sector from the very beginning of the research project, started in 2001, and the Case Company (or one of their Business Areas) was involved from that time on. The decision concerning the selection of only one focal company within this thesis was based on the results of the exploratory study in 2002 as was pointed out in Section 1.4.

Along the study this Case Company will also be called the focal company for the following reasons: 1) the focal company is the only firm with direct ties to every other firm in the network, and 2) as the nodal firm, the focal company not only has

direct ties with each supplier, but also has some economic interdependence with each supplier. The next chapter explains more thoroughly the criteria for selecting the Sub-Cases from the Case Company.

Selection of the Sub-Cases

In the empirical part three R&D programs, known also as Sub-Cases, represent the units of analysis. Each R&D program was selected together with the business unit collaboration manager or the relationship manager. The R&D programs of this study have been selected so that each Sub-Case represents one business unit within the selected Business Area of the focal company. Sub-Case 2 is an exception, because the organization in question is actually a business line within the real Business Unit 2. However, in practice and due to the history, the business line could be called a business unit like the other two business units.

In addition to being part of different business units, the selected programs vary in the nature of the *product*. In fact, the formation of the business units is based on producing different types of products. All the R&D programs selected for the study and the products being developed within these are complex and highly innovative technologically. The reason for this kind of scope was to show that R&D collaboration includes extensive information sharing. The product is being developed in the R&D organization as a distinction to the sourcing unit's R&D[4]. Another feature of the product is that they could be either hardware (Sub-Case 3) or software (Sub-Cases 1 and 2).

Another selection criterion of the Sub-Cases was the *time* of the R&D program: each R&D program was finished less than a year before the beginning of the interviews except the one program that was not yet finished at the time of the interviews[5]. This

[4] These products are usually called black box products

[5] However, the work-in-progress of this program did not have an influence on the analyzed factors, since the R&D supplier's involvement ended in June 2005, and in this sense it was possible to follow the program till the end.

way it was possible to avoid memory retrieval problems, and the persons involved in the programs were easier to catch for the interviews. Moreover, a further selection criterion of the Sub-Case was that the R&D program should be *typical*, meaning that each Sub-Case provided a prototype of a certain class of R&D programs. The intention was also to avoid rare cases.

Finally, the last criterion in the Sub-Case selection related to the *capability of the R&D supplier* involved in the program: in one program the R&D supplier had the capability to develop the product already before the program began; in the other program both the program and the R&D supplier had this capability (the capability had been increased step by step), and in the third program the product was new to both parties in the beginning of the program. The selection of the R&D suppliers was actually an easy one, since there were typically only few R&D suppliers in each program.

To summarize, the following figure illustrates the Case Company, the three Sub-Cases, and different parties involved in the study.

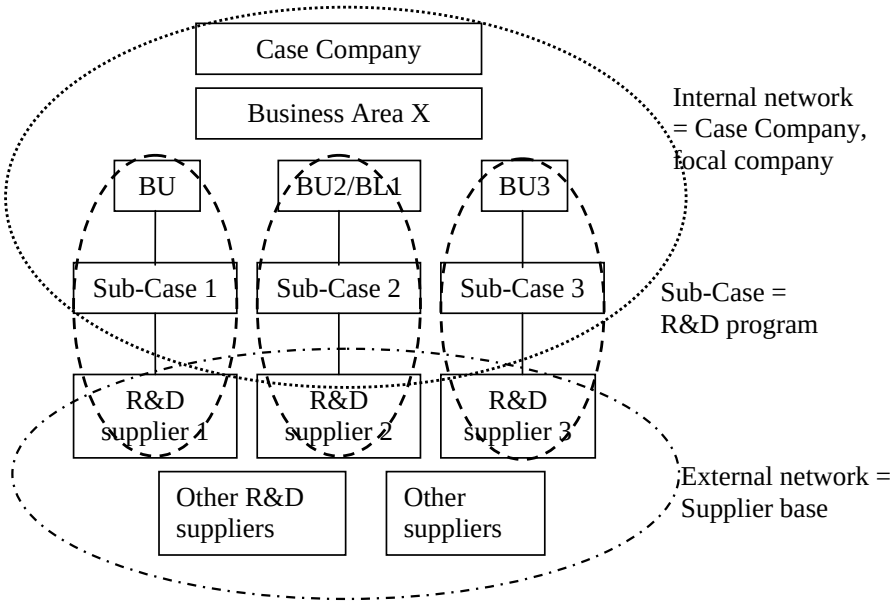

Figure 3. Empirical research context

The figure above illustrates the linkages between the focal company and their supplier network, the Sub-Cases selected for the study, as well as the R&D suppliers involved in the study. Other R&D suppliers and other suppliers may be common or divergent: for example, the documentation suppliers are common to all business units. On the other hand, in Sub-Case 3 the supplier base differs from the other Business Units mainly due to the distinctive feature of the product (a hardware product instead of a software product).

The network perspective is regarded as a starting point in the study, although the interviews regard collaboration only between two parties (thus, on the relationship level). The network perspective is important, because the actions of the other parties in the network also have an influence on the specific relationships, and vice versa: actions in one collaborative relationship influence the other parties of the network.

However, there are some challenges relating to this kind of research approach. First, the supply networks may consist of hundreds of companies, which make it impractical to involve most network players in the research. Second, the identification of objective network boundaries is theoretically problematic, making it difficult to distinguish who is in and out of the network. As contended by Harland et al. (2004, 2), "the analyst, depending on the focus of investigation, can determine the boundaries of a supply network". In other words, we could examine a supply network for a firm that could be represented by the set of upstream or downstream organizations it deals with. According to Harland et al. (2004, 2), "this would provide a map of all relationships within that firm's supply network." Furthermore, as Harland (1996) explains, the activities in the dyads are displayed in networks, and thus, the dyadic relationships also provide a basis to study networks. In this thesis, the focus is thus limited to a small number of key actors (business units 1–3 and R&D suppliers 1–3 in three R&D programs), creating three sub-networks as a proxy for the total R&D network.

After defining the case as well as the Sub-Cases, there is a need to explain more thoroughly the linkage between the context and the case, and what they mean within this particular study. As explained by Eriksson and Koistinen (2005, 7), context consists of those actors and actions, where the selected case is closely related. That is, *the case is a smaller part of the whole context.* According to Pettigrew (1997, 340), "social processes are deeply embedded in the contexts that produce and are produced by them." Within this study this means the recognition of the contextual factors that have an influence on information sharing.

2.2 Research strategy

The research strategy includes considerations on the type and nature of the research, research methods, and unit of analysis. This section begins with an argumentation for

the case study, after which the unit of analysis will be presented. Finally, the research method (abduction) will be described.

Case study

This study aims to find a solution for the needs of the Case Company, which will be accomplished by asking questions "why" and "how," with the purpose of qualitative research being to provide a more extensive understanding of the studied phenomenon. One type of study in qualitative research is the case study, which has been defined for instance by Yin (1994, 3) in the following way: "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context; when the boundaries between phenomenon and context are not evident; and in which multiple sources of evidence are used." Additionally, the *extent of control* over behavioral events may lead to a case study. (Yin 1994) This means that the case study is preferred in examining contemporary events, but under a specific condition: when the relevant behaviors cannot be manipulated.

The main argument for the case study research method here is that the research problem is very complex in its nature: it includes many variables and concepts which are not easy to grasp with a quantitative study, for example. Furthermore, because the empirical research context is a contemporary event, it leads to multiple sources of evidence, like interviews, introductory and informative sessions with the research advisors in the Case Company, and using of company-specific documentation. Also, the unit of analysis in the research is very complex, and certain variables stemming from the R&D collaboration context cannot be easily excluded: this means that it is impossible to carry out any experimental research.

Finally, there are some other advantages in the qualitative research, which makes collecting data and drawing conclusions easier along the study: flexibility, richness in nature, holism, assessment of causalities, possibility to locate meanings, and natural setting of the context, among others. (Miles & Huberman 1994)

When conducting the literature review, the Author performed an extensive desk study. In this sense the research was *conceptual* in its nature, although the existing theory was also developed further and a new framework was built. The framework was mainly postulated from the supply management perspective. The fields of Knowledge Management, Organization Theory could have provided interesting insights in the research problem, but these were intentionally left out of the focus. Expressly, the study aims to increase current understanding in the field of Supply Management.

The origins of the empirical research to a large extent leaned on the research project, and the research interest as well as the preliminary theoretical frames originated from that project. Therefore, the research project was a sort of a pilot study, *an exploratory research,* which was used as a basis for formulating more precise research questions. (Gummesson 2000, 85) However, for the most part this present study is *a descriptive case study*. According to Yin (2003), the aim of a descriptive case study is to describe an intervention and a real-life context in which it has occurred. Gummesson (2000) reminds us of the beliefs that description is considered less prestigious in scientific circles, meaning that description is mere observation, reporting, and summarizing other people's opinions. Still, as Gummesson (2000, 85) points out, "in making descriptions, we have to make choices, and these choices are guided by our paradigm, access, and preunderstanding. There is no description without analysis and interpretation." To sum up, this kind of research approach requires a deep understanding of the case context: why is information sharing as it is, and more particularly, which contexts influence information sharing? Therefore, it is well-reasoned to describe thoroughly both the case context and the nature of information sharing. This work is done especially in Chapter 5, whereas the Author's interpretation and analysis will be presented in Chapter 6.

Unit of analysis

The definition of the unit of analysis is an important phase in the research design, since it is related to the way the initial research questions have been defined (Yin

1994). Also, the unit of analysis may be either *holistic or embedded*: the former refers to one unit of analysis, whereas in the latter the attention is also paid to the sub-unit(s) of the case. In this study each R&D program is considered a unit of analysis. Therefore, this single case is analyzed in an embedded way. To be more precise, three R&D programs of the Case Company's Business Area X are under examination and they are called Sub-Cases. Accordingly, this study is an *embedded* single case study with multiple items.

An argumentation for using three R&D programs of three business units as Sub-Cases is provided in the study by Jordan & Tricker (1995). According to the authors, the decentralization of business units has enabled the units to pursue strategies that are almost independent, to such an extent that the business units can be regarded as distinct entities within a set of overall organizational constraints. The business units also contain considerable diversity in terms of products and a rich variety of structures and business strategies, and provide unique opportunities for studying them separately.

Since the *perspective of analysis is the focal company and how it perceives information sharing in R&D collaboration*, the case study is defined as a single case instead of multiple case studies, in spite of the three separate Sub-Cases. This decision is based on the argument that since the focal company is the same in each R&D network, there are similarities in strategic decisions, organization, and company culture. Another significant limitation concerning the research perspective deals with focusing on the *focal company interviews* only. This is partly a question of resources: the number of interviews is limited as the main source of data, and it was found more important to focus on an in-depth understanding of the focal company perceptions in governing information sharing. To be more precise, since the focal company is the key actor in the governance, its perspective becomes emphasized.

Still, there is no denying the importance of also considering the perceptions of the suppliers: their opinions would have provided valuable information into which

direction the means of governance could be developed or whether the suppliers receive enough information in the first place. In fact, the supplier interviews were in the original research plan, but partly due to the confidentiality issues related to giving information by a third party was the predominant factor that led to excluding supplier interviews.

The decision to focus on the focal company perceptions only also had an impact on the theoretical approaches, and a different research perspective would also have required fundamental changes in the theoretical framework. Furthermore, since the research target as such already provides an extensive research arena, it was decided to study it more in depth instead of looking at both sides of the relationship.

Abduction

This study also has characteristics from an *abductive* research approach. Traditionally there exists two central research approaches, namely, deduction and induction. The main difference between these approaches is that deduction moves from existing theories to a specific case, whereas induction starts with real-world data, and ends in a theory. In other words, deductive research tests an existing theory, whereas inductive research primarily generates new theory. (Gummesson 2000) However, as pointed out for instance by Kovács & Spens (2005), there is a need to utilize the abductive approach especially in the development of new theories in Logistics and Supply Chain Management. Although often presented as a third form in addition to induction and deduction, Gummesson (2000, 64) points out that "the term [abduction] may be useful to stress the combination, but it is misleading if perceived as a third type of approach." However, since this study has more features of abduction than of induction or deduction, it is applied in this study.

Abduction can be defined in the following way: "Abduction is about investigating the relationship between 'everyday language and concepts', which is similar to induction." (Dubois & Gadde 2002, 555, citing Peirce 1931; Kirkeby 1994) Nonetheless, when in the inductive approach not even the prior understanding, nor

the knowledge or a general frame or literature is necessary, in the abduction some pre-perception and theoretical knowledge already exists (Dubois & Gadde 2002; Kovács & Spens 2005).

Kovács & Spens (2005) describe the features of abduction in ways that corroborate its role in the present study especially when regarding the contextual analysis. According to the authors, the abductive approach is concerned with particularities of specific situations that deviate from the general structure of such situations. Additionally, it helps to determine which aspects of a situation are generalizable and which aspects stem from situational environmental factors, for example. Also, "abduction works through interpreting or re-contextualizing individual phenomena within a contextual framework, and aims to understand something in a new way, from the perspective of a new conceptual framework" (Kovács & Spens 2005, 138).

According to Kovács & Spens (2005), abduction emphasizes the search for suitable theories for empirical observation. Dubois and Gadde (2002) call this *systematic combining*, as the research method is characterized by a continuous movement between the empirical world and the modern world. In other words, "systematic combining is a process where theoretical framework, empirical fieldwork, and case analysis evolve simultaneously..." (Dubois & Gadde 2002, 554).

The following figure illustrates the abductive research process and moving between theory and empirical observation.

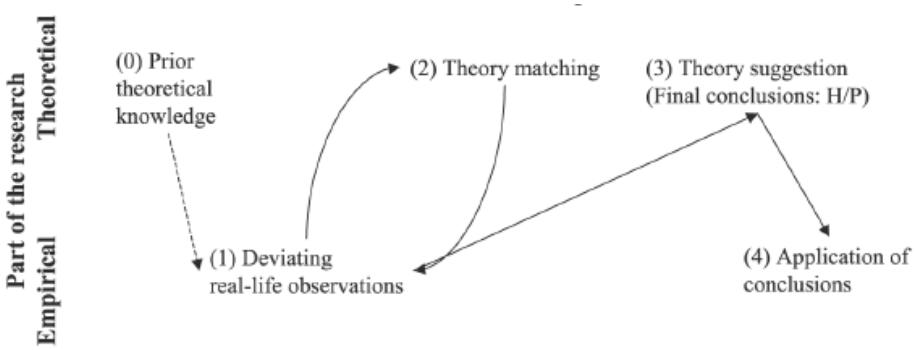

Figure 4. The abductive research process (Kovács & Spens 2005, 139)

As was explained in Section 1.4, this study is based on the experiences and findings gained during the research project taken place in 2001–2003 during which the issues of information sharing – its context-dependency and significance of the means of governance – became relevant (1). The first literature reviews and theoretical framework origin from these research indications (0, 2). The abductive reasoning and systematic combining started (1), as it was noticed that empirical observation did not match these prior theories (Dubois & Gadde 2002). That is, a "new" empirical case was created (information sharing in R&D collaboration), and the theoretical framework developed during the exploratory research project was updated and refined (an a priori framework presented in this study in Section 4.2). Having conducted the interviews for this study, this framework was updated in the context of R&D collaboration (Section 6.1). Yet another look at the theory was taken, and these insights were brought forward once again (3, 4).

In sum, the research process is characterized by what is called systematic combining, which is based on the logic of abductive reasoning. This research approach emphasizes going back and forth from one type of research activity to another and

between empirical observation and theory. In this way, as Dubois & Gadde (2002) suggest, the researcher may develop an understanding of both the theory and empirical phenomena.

2.3 Data collection methods and data analysis

The data collection methods of the study included introductory sessions held with the company representatives (the secondary information sources), in-depth interviews (primary information sources), and other company-specific data, such as documents. In addition, the experience and material gained during the research project were valuable in a sense that it was easier to understand the research context: the Case Company's general strategies, company culture, supply management processes and information sharing processes, products, and the historical reasons that may have had an impact when collaborating with suppliers. However, this material is not used in this study: it only serves as preunderstanding for the Case Company and ICT business. The following sections provide a description of the data collection process.

2.3.1 Sources of data

The interview process began in December 2004. In the first phase the selected person in the Case Company was contacted. The research objectives and limitations were refined together with two advisors nominated from the Case Company for this study. This was a great help when translating the theory-formed research questions in the "company language" and when deciding, for instance, which parts of the R&D process will be taken into consideration. This *introductory phase* helped in getting background information for the in-depth interviews and additional data concerning the focal company, Business Area in question and their organization, general guidelines and the basic information concerning the R&D process. Another essential issue of the introductory phase was the dealing with NDA (Non-Disclosure

Agreement) issues. Finally, the introductory session helped in the implementation of the interviews: the contact person sent an email to the selected persons in each business unit to ease the Author's entry in each business unit's R&D program.

All in all, the introduction to the empirical case was implemented in two meetings, and after refining the focus of the empirical research, two introductory "interview-type" sessions were held with the key informants. These sessions focused on two main issues: 1) general information concerning the Case Company, the Business Area X, as well as business prospects in telecommunications, and 2) the R&D process of the Business Area X. In addition to these four meetings some emails were sent and telephone calls made to sharpen the empirical research focus and to get enough background material from the Case Company. Appendix 1 lists the sources of these secondary data sources.

The *interview data* was collected in February–April 2005, and the interviews were conducted on two levels: the business unit and the R&D program. In each Sub-Case there were several interviewees from the collaboration management level to the program level (program management and project management including program managers, project managers and sub-project managers). Altogether 19 interviews were held. The following figure illustrates the Sub-Cases in the Business Area X organization and the positions of the interviewees.

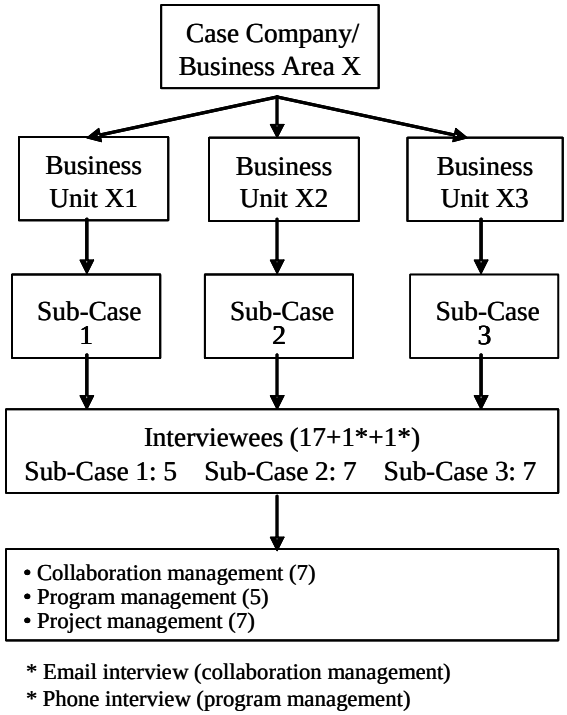

Figure 5. Interviewees in the Sub-Cases

The interviewees' selection was based on their duties and responsibility in the program. The program manager made this decision in Sub-Cases 1 and 2, while in Sub-Case 3 the relationship manager selected the interviewees. The titles of the interviewees cannot be revealed because, firstly, the purpose is to protect the Case Company's organizational structures, and secondly, the rough categorization is regarded informative enough in this study.

The interviews were *semi-structured theme interviews* in their nature, which helped to gain a holistic view of information sharing in R&D collaboration. An argument for semi-structured interviews with a loose framework is provided by Love, Li & Mandal (1999): Open interviews stimulate conversation and break down any barriers that may have existed between the interviewer and interviewee. The interviewee is allowed to

talk freely without interruption or intervention, so as to acquire from their perspective an understanding of why and how the events associated with their contract occurred.

The interview framework is presented in Appendix 2. The framework fluctuated with the position of the interviewees, meaning that not all the questions were asked in every interview. For example, the discussions with the collaboration management focused on the nature of the industry and collaboration in general. The program management level was regarded experts concerning the nature of the R&D program, the progress of the program as well as the practices applied in the program. The project management was the best source for describing the nature of information sharing and collaboration with the supplier in practice.

All except two interviews were conducted in face-to-face meetings – one phone interview and one email-exchange-based "interview" were carried out due to the physical distance. Before each interview the interviewee got an email concerning the interview framework and introductory slides of the thesis including the terminology, research questions, and the context of the study, among other things. This helped the interviewees to be prepared for the interview session beforehand.

In the interview the background of the research as well as the interview process were clarified to everyone. All interviews were taped and transcribed, and memos were written in each interview right after the interview and sent back to the interviewee for verification. All the interviewees except three returned a commented interview memo. This verification phase was very important, because the interviews were held in Finnish, and the memos were translated into English. The transcription of data was done later in the autumn 2005. The transcriptions were done nearly word for word, marking the emphasized words in capitals and pointing out other expressions (e.g., laughter). Longer breaks were also indicated in the text. Interview transcriptions contained altogether 350 pages, making approximately 18 pages per each interview. The average length of an interview was 84 minutes, while the duration of the interviews varied from one hour and 15 minutes to 2 hours.

Interviews increased the Author's understanding firstly in terms of the whole ICT business, which was important due to the constant changes taking place within the industry. Secondly, the interviews could provide a broader view of many contextual issues that were related to the complex research area. Finally, the interviews were of course targeted to handle the specific and focused occasions of information sharing and R&D collaboration as well as their management aspects.

In addition to the interview data, some other information in the company was acquired. This data mainly consisted of *public information, such as the company's websites and books* written about the ICT sector and/or the Case Company. Additionally, *company-specific documents* (product and process descriptions, program plan, organization charts, etc), several phone calls made before the actual interview or meeting, and the exchange of emails increased the understanding of the case context. Company-specific documentation provided exact data, a broad coverage of concepts, settings and events related to the research area.

2.3.2 Classification and analysis of the data

This chapter explains the procedure for classifying and analyzing the interview data (known as the case study protocol, as Yin 1994, calls it). In the first phase this was done with the memos that were written down during the interviews. In the second phase the data was classified and analyzed after transcribing the interviews.

The following list includes the steps taken in the process of classifying the data gained in the interviews and in the introductory sessions:

1) A general overview of the interview data (making notes online during the interviews, listening to the tape, and updating the notes). The interview memos were written and sent to each interviewee for verification.
2) Reading through the interview memos: marginal remarks were made in order to highlight the topics of discussion. The interview coding was created (see

Appendix 3). It was based on i) the contextual factors of the cases, and ii) the nature of information sharing. The governance of information sharing (practices, success factors, lessons learned) was included in the contextual factors to emphasize their appearance in the specific program/project.

3) Preparing the interview summary: the counting of the events (according to [Miles & Huberman 1994, 69] this is called the *first-level coding*) and their classification according to the main categories per R&D program (business context, information sharing specific issues, R&D supplier and program management and other governance practices and lessons learned). Referring to Miles & Huberman (1994, 69), this is *pattern coding.*

Another part of the classification was done later after the transcription of the interview data. The procedure was similar to the one mentioned above in that the process and interview coding remained the same. However, at this time the interview summaries were done differently: the summaries of each main research issue were generated into Excel worksheets (altogether 27 worksheets) according to the case contexts, content, media, and challenges of information sharing, among other things.

After classifying the interview data, the analysis process began. It was first done by utilizing the interview summaries of the Excel worksheets. This phase helped in creating a deeper understanding of the big picture, and it was easier to find out the most emphasized issues. To find out relations/dependencies and explanations between the program contexts and the nature of information sharing, for example, mind maps were drawn. Appendix 4 includes examples of the interviewees' comments on the interrelations between different factors (codes and sub-codes).

Attention was paid to the issues that were most highlighted in the interviews. The analysis of the data did not concentrate on cross-case comparison as such, but on comparison of the contextual factors inherent in the Sub-Cases. Therefore, the research results reported in Chapter 5 include extra notifications, if one phenomenon is highly emphasized in one or two particular Sub-Cases. However, it was found that

evaluating differences between the programs often proved difficult: as an example, it was difficult to define which of the products in the R&D programs was the most complex one (instead, the complexity of the parts of the products was easier to evaluate).

The transcription of the interviews resulted in more detailed interview summaries than was possible when using the interview memos as the main source of data. After generating the research summary for the Case Company, the analysis went further. Firstly, the iteration of the company-specific research results was done by preparing a case report, and the thesis advisors and other competent persons they nominated in the Case Company could check the consistency of the interview results. Secondly, theories and new literature references were studied in order to either find support to or explain the interview results.

The analysis phase included evaluating the research quality, and the sources of data and the representativeness of the data had to be taken into account as well. The interviewees had a strong and wide background of the business in question. Before each interview the interviewees were asked of their previous and current duties. This helped in analyzing the relevance of each interviewee's opinion (if the person had been only a short time in their position, the data would not have been that valuable). However, careful planning in the selection of the interviewees turned out to be fruitful and was noticed here: all the interviewees had been at least six years with the Case Company and most of them in the same business unit and in the R&D programs in specific. Nevertheless, it is worth mentioning that a couple of the interviewees were no longer in the position or in the same business unit the interview handled, but they spoke about their experiences in the R&D program and the relationship being involved in.

Also, the selection of the programs based on their time of occurrence proved to be the right decision, although some interviewees still had memory retrieval problems (especially in terms of exact dates of the program milestones). This problem was

eliminated by asking the same questions of different interviewees, which helped in collecting a comprehensive and coherent view of each problem area. Access to other program information and documents also led to a detailed view of the program, and the memory retrieval issues could be verified easily.

Appendix 5 summarizes the data collection process as well as the analysis of the data.

2.4 Evaluating the scientific research quality

The scientific quality needs to be judged by various criteria. Remenyi et al. (1998) consider that the case study may be judged on the basis of three types of validity: namely, construct validity, internal validity, and external validity. Additionally the reliability of the research must be evaluated.

Validity

Validity is the success in measuring what we really want to measure. *Construct validity* refers to establishing correct operational measures for the concepts, ideas, and relationships studied (Remenyi et al. 1998). In this study the construct validity has been ensured by a careful identification and conceptual analysis of the ideas and relationships first in the theoretical part. The empirical study provides a richer part to study the correlations of research issues more in depth and in a real-life context (see especially Chapter 5). The construct validity was further increased in conversations with the Case Company advisors: they contributed, among other things, to the conceptualization of the term *information sharing* and its meaning in the R&D collaboration context.

Yin (2003) suggests that three kinds of principles should be followed when trying to increase the construct validity (and reliability) of the empirical data collection. The first step is to use multiple sources of evidence. Then, the case study database should be prepared (will be explained in the section Reliability), and finally, the chain of

evidence must be maintained (was explained in Section 2.3.2). In this study the primary interviews served as the main source of evidence, but additionally the secondary interviews, company-specific documentation and also the experience and documentation gained during the research project in 2001–2003 were used as sources.

Silverman (2001), on the other hand, suggests two ways in which to validate the study: triangulation and respondent validation. The first method is similar to pursuing multiple sources of evidence, while the latter means taking one's findings back to the subjects being studied. If these findings are verified by other people, one can be more confident of their validity. In this study respondent validation was used as an example after the introductory interviews, when the key contacts suggested that *competence transfer* would be an important issue in the management of information sharing. This was verified in the primary interviews in all Sub-Cases. Secondly, some issues arisen in the first interviews were given additional attention in the subsequent interviews. For example, since the influence of task characteristics on the information sharing became highly emphasized from the very beginning, this question was asked in more detail later on in other interviews.

It proved more difficult to be sure of the *internal validity* as it is of concern in all causal and explanatory studies of the relationship between different events (Remenyi et al. 1998). In the case study this means that the researcher must be sure of making the conclusion that a particular result was caused by a particular phenomenon. Discussions with key informants and contact persons in the Case Company have been of help when determining the detailed knowledge of each idea and relationship arisen as a consequence of the interviews. Examples of these types of causalities are given in Appendix 4.

The *external validity*[6] refers to the generalization of the study and its replication logic. It has already been stated that this study does not aim at statistical generalization, but at analytical generalization. This means that the basic objective of this kind of research is to expand and generalize theories. (Yin 2003, 10) At this point it is essential to highlight the purpose of doing qualitative research. Since qualitative research does not aim at any numeric generalization, it is not purposeful to evaluate context-dependent factors according to their appearance or significance. Instead, the study aims to find out such factors that have been found influential in the studied Sub-Cases. In other words, this study and the research methodology is not useful for statistical generalization, but it could be used as a starting point for further, rather quantitative, analysis. Only after data generalization, the different characteristics in the information sharing context could be put in the order of importance. That is, this study is designed to identify possible factors arising from R&D collaboration context, and explain how these may have an influence on information sharing.

Reliability

Reliability refers to the issue of whether the evidence and the measures used are consistent and stable. This means that if someone else would conduct the same research, the results would be the same. Because there is always some subjectivity of the researcher involved in the process (e.g., researcher's intuition, flexibility, and number of random errors), the research process should be described carefully so that anyone else can repeat the study.

In terms of the reliability of data collection, Yin (1994) first proposes that investigators should confirm the skills of investigators (if there are many). Second, the case study protocol should be followed, and third, pilot studies should be carried

[6] Like the external validity, reliability is closely related to the generalization and is very questionable in the study of business and management: all situations and organizations are different, and thus the same results cannot ever be obtained again, which actually makes reliability not a central issue (Remenyi et al. 1998, 181). The second reason is that one cannot manipulate and control conditions. The case study results can be used as a basis for further research along the line of the process proposed by Eisenhart (1989).

out. Also, the generation of a case study database helps increasing the reliability. In this study all the means mentioned above, except the pilot study, have been used at least to some extent. The case study protocol has been described in Section 2.3.2, and the whole research process is summarized in Appendix 5.

The pilot study as such has not been established. Instead, a lot of experience was gained when doing research with the same Case Company and the same Business Area during the research project. Furthermore, the discussions and introductory sessions held with the Case Company's advisors helped in preparing for the real interviews. In addition, the first interviews showed that following a strict interview framework was not fruitful and in the subsequent interviews the research method was changed to get more information on the larger context.

The case study database is large, because the classification and analyzing of the interview data was done in two phases: after writing the interview memos and after the transcription of the data. All in all the case study database consists of different kinds of memos drafted i) in the introductory sessions, ii) in the interview session (original, hand-written memos), iii) right after the interview session (the memos completed after listening to the tapes), and iv) commented memos sent for verification to each interviewee. Additionally, the case study database includes transcripted interviews, emails exchanged with the interviewees and the advisors of the Case Company, and different kinds of interview summaries.

3 MANAGING INFORMATION SHARING AS A NETWORKING ACTIVITY

This study deals with supply management issues inherent in information sharing during R&D collaboration. Information sharing is regarded as an essential activity in the supply (here R&D) network. The literature on Supply Management is regarded as a good starting point in understanding and explaining complex interaction between organizations as was explained in the Introduction.

The theoretical part is divided into two main chapters: In Chapter 3 the concept *information sharing* is explained and analyzed as a networking activity. After that the benefits, challenges and risks related to information sharing will be summarized, and some of the means to govern information sharing will be presented with the theoretical reasoning for managing information sharing activities. Especially the supply management perspective will be brought forward in the sharing of information. The following chapter (4) continues from these standpoints by clarifying the importance of network and relationship analysis and explaining how it is linked with the concept of context-dependency. Then, an a priori framework for analyzing the contexts of networking activities will be presented. In the subsequent section the focus is on the context-dependency of information sharing. The following figure illustrates the structure of the theoretical part as well as its linkage to the empirical research:

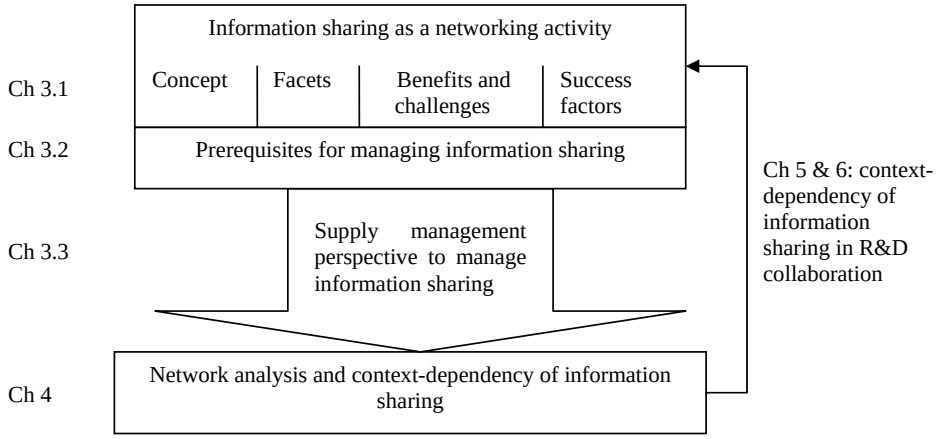

Figure 6. The structure of the theoretical approaches to study context-dependency

This study moves from the description of the information sharing activity to considerations about the ways it can be managed. Consequently, in the thesis it will be suggested that it becomes highly important to analyze more profoundly the business environment where the company is operating. Therefore, the theoretical part of the study not only reveals the importance of context-dependency and how it emerges in information sharing, but also provides a framework in which this context-dependency can be studied.

3.1 Information sharing as a networking activity

This section clarifies information sharing as a networking activity. The aim is to present previous studies in information sharing conducted in the field of Supply Management and thus, to shed light on the complex field of information sharing research. Then, the phrase *information sharing* is conceptualized and the characteristics of it will be categorized. This categorization will be used later in the study when analyzing the nature of information sharing in R&D collaboration.

In the next phase the information sharing activity will be analyzed through the benefits and key concerns (challenges and risks). Then the success factors or practices found critical in the field of information sharing and related collaboration activities will be reviewed. This type of analysis will deepen our understanding of the complexity of managing information sharing.

3.1.1 Overview of the past research

When revealing the nature of information sharing, we are confronted with a huge research arena, covering a lot of perspectives and approaches from different research streams. Originally, Shannon's *Information Theory* (Shannon & Weaver 1949) introduced the whole question of information transmission, by focusing on the media and thus, opening a discussion of the effects of media on the communication process (Fourboul Voynnet & Bournois 1999). However, Shannon's theory was very mathematical in its nature, and has been supplemented by many other theories. One theory that links closely to Information Theory is the *Social Exchange Theory*, on which, for example, Kelley & Thibaut (1978) and Constant, Keisler & Sproull (1994) – as noted in the study by Jarvenpaa & Staples (2000) – build their advances in the theory of information sharing. The starting point in the theory of Constant et al. (1994) is to understand factors that support or constrain information sharing in technologically advanced organizations. However, the starting point in their study is to analyze factors among individuals, as typical to the social exchange theory.

When talking about information theories, expressly, *Information Systems Science*[7], one of the basic issues is the role of information systems in information sharing. In

[7] Additionally, the traditional *Information Management* literature is interested in the research of information, although it is worth mentioning that information management often concentrates on pure information within its core context (e.g., libraries). *Knowledge Management* is also a theory closely related to information sharing. In fact, some of the researchers claim that explicit knowledge actually refers to information (see e.g. Nonaka & Takeuchi 1995), and in this sense information and knowledge cannot even be separated.

fact, it is obvious that the trend to study information systems has been increasing over the recent years along with the technology progress. Most of the studies have considered the use and impacts of electronic data interchange (EDI)[8] and web applications, like the Internet, intranets and extranets (Alshawi 2001; Croom 2001; Deeter-Schmelz & Kennedy 2002; Graham & Hardaker 2000). Additionally, other forms of information sharing and communication have received attention among the researchers, like studies analyzing the role of face-to-face meetings, and traditional information sharing methods like fax, phone, and email (see e.g. Larson & Kulchitsky 2000 and Leek, Turnbull & Naudé 2003).

Within the business studies, it was originally *marketing research*, where the studies into information sharing and communication has been the richest. Especially well-known are the studies on *Channel Communication* and *Relationship Marketing*, with references to Mohr & Nevin (1990), Morgan & Hunt (1994) and Mohr (1996).

Most of the existing research on information sharing has focused on analyzing *operational information sharing*; procedures, tools, methods and impacts on the supply chain performance, or as stated by Huang et al. (2003, 1508), "the majority of the literature has been focusing on the level of production planning and control." More generally, most of the research in the field of Purchasing and Supply Management has dealt with the *managing and handling of operational data*. This data is most regarded as product information, process information, resource information (capability and capacity), inventory information and planning information. As an example, Lee, So & Tang (2000) point out the importance of sharing sales information in order to reduce the bullwhip effect (see also Lee, Padmanabhan & Whang 1997). Hull (2002) dealt with operational, demand information flows and their description in the supply chain, whereas, Småros et al. (2003) studied the impact of increased demand visibility on production and inventory

[8] Especially rich the research into EDI was in the 1980s and in the beginning of 1990s, see for example Lau, Huang & Mak 2002; Stefansson 2002; Strader, Lin & Shaw 1998.

control efficiency and the use of VMI (vendor managed inventory) as an information sharing practice. Zhao, Xie & Zhang (2002) in turn clarify the importance of information sharing and ordering coordination in improving cost efficiency and service level.

Studies on information sharing have taken place in different *research contexts* as well. The industry of the empirical case represents a larger context, where a study can take place. Quite a few studies have been conducted in the *ICT sector*: examples of these are Mohr (1996), Fildes & Kumar (2002), and Agrell et al. (2004). In fact, information sharing research has been extensive especially in the *automotive industry* in Japan (see e.g. Bensaou 1999 and Takeishi 2001). Another context is the intra-company level, where information sharing has been studied in different processes and functions.

For the most part researchers in the field have been interested in information sharing in the *logistics process*; but some studies have also been conducted on the *R&D* process (see the seminal work by Allen 1977; and various studies by Wynstra: Wynstra, Van Weele & Weggeman 2001; Wynstra et al. 2000; Wynstra & Pierick ten 2000; Wynstra, Weggeman & Van Weele 2003). Additionally, the following studies are worth mentioning in the field of R&D: Cummings & Teng (2003), Leenders, van Engelen & Kratzer (2003), and Zahay, Griffin & Fredericks (2004). Within these studies the empirical studies have mainly been implemented in the automotive industry. However, as stated in the discussion with the Case Company contact (Case Company Material 2004), "*our company does not always know what information is relevant at the moment to produce added value in the future. In comparison, the automotive industry has clearer components and base for information sharing*." This remark clearly speaks for the importance of analyzing the content of information in terms of its sensitivity and risk, which are supposed to decrease along the R&D process.

The overview of the past research in the field of information sharing tells us that it has been studied in several research streams and theories, from different perspectives (though focusing on the study of information sharing media), and in different research contexts. This helps us to understand how broad an issue is dealt with in this study, and why the narrow perspective of context-dependency is taken as a starting point. Also, the varying concepts and perspectives used in the previous studies also explain the need to focus more closely on the nature of information.

3.1.2 Concepts

This section presents and clarifies the varying terms related to the concept *information sharing*. Information sharing, communication, knowledge transfer, and data exchange – they all have a similar meaning as the concepts refer to the informational interaction between two or more participants. The conceptual field is far more complex, when taking into account the research tradition and the theoretical background (e.g., information processing view, knowledge management). In order to clarify the concept *information sharing* used in this study, this section also introduces another form of informational interaction, namely communication, and provides a comparison with the concept of information sharing.

Data, information, and knowledge

All businesses, processes and transactions are full of data – some less and some more unstructured. There are a number of concepts that relate closely to information sharing: data, information, communication, and knowledge. They have not always been defined distinctly and are used in a disorganized manner depending on the research stream and author[9] (see Gooijer 2000; Kumar & Palvia 2001; Lueg 2001; Lummus & Vokurka 1999; Mason-Jones & Towill 1998; Noorlander 2001;

[9] In Allee's (2003, 81) opinion, "there will never be a universally agreed definition for either knowledge or information." Later on she continues: "…there is no such thing as *pure* information, data, or knowledge."

Ramaprasad & Rai 1996; Rowley 1998; and Warkentin, Bapna & Sugumaran 2000). The most consistent views concern the definition of *data*. According to Davis & Botkin (1994), "data can be displayed as a form of numbers, words, sounds and images, and data are the building blocks of the information economy."

The definition of *information* is more complex, and there are several of them. First, it can be described as "data that have been arranged into meaningful patterns" (Davis & Botkin 1994). Sveiby (1996, 382) points out the Oxford English Dictionary definition of information, and how it is connected both to knowledge and communication: "Information is knowledge communicated concerning some particular fact, subject or event; that of which one is apprised to tell; intelligence, news."

Often information is regarded as explicit knowledge (Nonaka & Takeuchi 1995), and is differentiated from another familiar concept, "tacit knowledge". In fact, *knowledge* refers to the application and productive use of information (Davis & Botkin 1994), or as stated by Nonaka & Takeuchi (1995, 58), "knowledge is about beliefs, commitment and action. Thus, information is context-specific and relational, and a flow of messages."

In this study the following definition of information is used: "Information refers to anything in verbal, written, or symbolic form that can be read, viewed, heard and comprehended by another human being" (Allee 2003, 82). She emphasizes that all interpretation and understanding is social in nature, which leads us to the discussion on the action of information sharing.

Information sharing and communication

Halinen (1997) makes a distinction between information sharing and social exchange, which together constitute the concept *communication*. Fourboul Voynnet & Bournois (1999) refer to Laramée (1989) when comparing information to *communication* and stating: "Information is considered to be data which has acquired attributes of significance, whereas communication is a process of transmission where behavior

plays an important part." Yet another classification is provided by Mohr & Spekman (1994, 139), who define information sharing referring "to the extent to which critical, often proprietary, information is communicated to one's partner."

The phrase *sharing of information* could be used as a synonym for *exchange* or *communication* with only slight distinction: exchange takes place between two or more partners, whereas sharing is one-way (in this research, information sharing origins from the focal company, and sharing is a well-reasoned concept to be used). On the other hand, Johnsen et al. (2000) speak about *information processing*, when describing information activities in a network. According to Jarvenpaa & Staples (2000, 130), information sharing embeds the notion of *willingness to share*. Accordingly, *involuntary information sharing* is actually called information reporting, whereas information sharing is understood as a *voluntary* act of making information available to others.

To summarize, the phrase *information sharing*, used in this study, refers to the voluntary, one-way act controlled by the focal company. Information sharing is regarded as an interaction process between the buyer and their suppliers, although here the interaction is considered only from the focal firm's perspective due to the limitation. The definition provided earlier by Mohr & Spekman (1994) is useful in the context of this study. It not only expresses the content of action, but also relates the communication aspect to the concept. Although *communication* – referring to the social exchange between individuals – is intentionally limited out of the focus of this study, it cannot be totally ignored. In fact, when describing information sharing in R&D collaboration in particular, drawing the line between information sharing and communication may be difficult. Especially when dealing with information sharing media, the role of communication and its social dimension is emphasized. In other words, sharing of information, for example, during face-to-face meetings involves a high amount of social exchange, and therefore the communication aspects must be included in the analysis.

To clarify the difference between information sharing and knowledge, it can be said that smooth and efficient information sharing requires a sufficient level of knowledge, skills, and capability. Therefore, when analyzing the contexts of information sharing, the role of knowledge is always at hand especially on the level of individuals.

3.1.3 Facets of information sharing

The characteristics or facets of information (sharing) influence the way in which the information sharing activity can be evaluated. Information quality and quantity are the main determinants. Leung, Wong & Chow (2003) classify information quality into content, form, and time characteristics, of which information content plays a major role in identifying information quality. The authors introduce information quantity that refers to the information flow frequency. On the other hand, Mohr & Nevin (1990) perceive frequency, direction[10], modality, and content as a combination of communication facets. Mohr & Spekman (1994) speak about communication quality, and contend that quality includes such aspects as the accuracy, timeliness, adequacy, and credibility of information exchanged. Furthermore, Albino, Garavelli & Schiuma (1999) contend that media is characterized by code and channel, which means that they regard code (i.e. content of information being exchanged) as part of the media. According to the authors, the channel is the means by which information is shared.

Finally, Maltz (2000) suggests three dimensions to be used to develop the typology of interfunctional communication modes: richness, spontaneity, and speed. He also defines the attributes of perceived information quality, and presents four dimensions that seem to affect perceptions of quality. These are credibility (the degree to which information is perceived by the receiver as a reliable reflection of the truth), relevance

[10] Directionality is not discussed in this thesis, because the starting point in the analysis is one-way information sharing, and therefore directionality is not relevant.

(the degree to which information is appropriate for the user's tasks or application), comprehensibility (perceived clarity of the information received), and timeliness (the degree to which information is perceived as current and actionable). (Maltz 2000, 114-115)

As it can be seen, the features or facets of information sharing vary a lot among the researchers. The following sections describe the nature of information sharing divided into three parts: the content of information, media to share information, and style of information sharing which include both qualitative and quantitative attributes.

Content of information

The content of information can be analyzed by qualitative features. The quality of information content refers to the following items, among other things (Schurr & Pazer 2002):

- Accuracy (the degree of conformity between the value actually used and the correct value);
- Completeness (the presence of data, i.e. structural completeness and the use of the most informative metric for information, i.e. content completeness); and
- Timeliness (the age and age sensitivity of data as contended by Schurr & Pazer 2002, or as Huang et al. (2003) state, the earliness or lateness of data).

Lysons & Gillingham (2003) add attributes such as:

- Economy (the cost of obtaining information must not exceed the worth of information);
- Intelligibility (information must be preserved in such a way that the recipient can understand it, closely related to completeness);
- Veracity (information can be checked for accuracy or reliability); and
- Simplicity (information is not too complex and information overload is avoided).

According to Mohr & Nevin (1990), *content* refers to the message that is transmitted or what is said. Typically content is categorized according to the type of exchange, or the type of influence strategy (direct, indirect). The type of exchange normally concerns product information, inventory information, pricing structures, etc. The direct strategy presented by Mohr & Nevin (1990) is designed to change behaviors of the target by implying or requesting a specific action, while in an indirect communication strategy no action is requested. Evans & Wurster (1997) divide information attributes into richness and reach, which include both the information content and sharing. Richness indicates the amount of information (bandwidth), the degree of customization of information, and interactivity. Reach will be dealt with in the following section in the style characteristics. According to Maltz (2000, 112), "richness refers to the degree to which the mode of communication is able to provide instantaneous feedback for the receiver, and to the number of cues that can be used by the receiver to interpret the information being communicated." This definition of richness is linked to the communication mode (see the following section).

The most general information shared between suppliers and buyers is demand information (Harland et al. 2004). In R&D collaboration the type or content of information is typically related to the design of a product. The most important levels are the operational level and the strategic level. Harland et al. (2004) highlight the importance of exchanging strategic information in the supply network in order to ensure the long-term prosperity of the network. This would include strategy, market, technology, and new product information. Larson & Kulchitsky (2000, 32), on the other hand, suggest that "strategic communication supports or shapes competitive advantage and may include information such as new market/product plans, long-term forecasts, and financial information." Another type of communication used by Larson & Kulchitsky is tactical communication, which refers to day-to-day operations. According to these authors, face-to-face contact and phone were strongly preferred in strategic communication while other media were used in tactical communication.

Zahay et al. (2004) classify new product information into three main types and use different classification criteria. Information types range from those internally developed to those obtained from sources external to the firm. Altogether eight types of information were identified:

- Internally developed information: strategic, financial, project management
- Internally and externally developed information: customer, needs, technical
- Externally developed information: competitor, regulatory

According to Zahay et al., instead of making a difference between the strategic or operational content, the source of information is the classification criterion. Within the limitations of this thesis, in the Zahay et al.'s classification the financial information, customer and needs information, as well as competitor and regulatory information is not considered here. To be more precise, the focus is on strategic information in general, and on operational information specific to R&D (mostly technical and project information).

Media

Advances in technology and IT have also brought forward the technological aspect in information sharing. Especially this trend has been visible since the turn of the millennium, along with the e-business and new economy hypes. Research in the field of communication media has been conducted, for example, by Baker (2000), Curry & Stancich (2000), Hong (2002), Larson & Kulchitsky (2000), Mirani et al. (2001), and Ruppel & Harrington (2001), whereas the implications of the use of IT have been studied by Alshawi (2001), Baraldi (2001), Kumar & Palvia (2001), Morrell & Ezingeard (2002), and Motwani et al. (2000).

The study of Alshawi (2001) is very extensive, as it takes into account the roles of both the information systems in the supply chain and the media (intranet, extranet, XML) involved in the transactions. However, the study does not look beyond the information systems, and other forms of sharing information remain uncovered. Leek et al. (2003) have discussed the change that the development of information

technologies causes in the use of communication tools. They have questioned the impact of the information technology revolution by asking if the new Internet technology-based methods (including mobile phone, email, audio- and videoconferencing) have replaced any of the older communication tools (landline phone, fax). According to the study, the newer methods of communication are enhancing interaction between businesses, but they do not replace the more traditional methods.

Mohr & Nevin (1990) present several ways in which communication media can be classified. According to their literature review, media can be either face-to-face, written, telephone, or other modes. Another categorization principle is to consider the medium's ability to transmit rich information, where face-to-face is the richest medium followed by video-phone, video-conference, telephone, electronic mail, personally addressed documents to formally, unaddressed documents. Other classifications have been made of commercial/non-commercial media (e.g. advertising/trade journal articles), personal/impersonal media (e.g. one-on-one contact/mass communication), and formal/informal media (written modes, meetings/word-of-mouth contact). (Mohr & Nevin 1990)

Larson & Kulchitsky (2000) distinguish between *personal (*face-to-face contact and telephone), *mechanical* (mail and fax), *and electric communication tools* (EDI and e-mail/Internet). Maltz (2000) presents four general modes of communication, namely written communication, electronic communication, telephone, and face-to-face. Another classification is made between a *synchronous and asynchronous medium* (Patrashkova & McComb 2004). Sakthivel (2005) also adopts this type of categorization, as illustrated in the table below.

Table 2. Communication media in group work (Sakthivel 2005, 306)

Real time or different time	Same place or different place	Type of communication	Examples of communication media
Real time	Same place	Richest synchronous	Face-to-face interaction
Real time	Different place	Rich synchronous	Television video conferencing, collaborative work products
Real time	Different place	Less rich synchronous	Desktop video and audio conferencing
Real time	Different place	Least synchronous	Telephones, conference calls
Different time	Same or different place	Asynchronous	Emails, file transfers

This classification takes time and place aspects into account. Synchronous media, such as face-to-face meetings and telephone conversations occur when two or more team members engage in the communication act at the same time. Asynchronous media refer to the communication that takes place at the different time (e.g., emails). These two communication media also differ in their capabilities to share information: synchronous media are called rich media since they are able to transfer more information per message than asynchronous media.

As it can be concluded, several information sharing media are available and their classification criteria vary. For the general comparison and argumentation of the use of different information sharing media, a basic classification has to be done. This thesis follows the categorization of asynchronous and synchronous media taking into account both time and place, which are important factors when describing the context of dispersed R&D teams.

Style

The style of information sharing is understood as features that describe the process of information sharing. The style of information sharing includes, among other things, the consistency (the formats or processes used to communicate data) (Schurr & Pazer 2002), spontaneity (whether the receiver has received advance notice of the communication encounter), and speed (the degree to which the sender can transmit information instantaneously) (Maltz 2000).

According to Evans & Wurster (1997), *reach* means the number of people who exchange information. Huang et al. (2003) use the term neighborhood within this context. It indicates those with whom the information is shared. Determining the companies involved in the information sharing process is essential, since information sharing is always associated with some costs (e.g., acquisition of information, installation of information system) and barriers (e.g., privacy of information).

Huang et al. (2003, 1500) have noticed that information sharing is mostly considered at two extremes: full sharing or no sharing[11], which refer to the *quantity* of information. The *transparency* of information is another key component when analyzing the *openness* or amount of information sharing. Doz & Hamel (1998) define transparency in the following way: "Transparency refers to the learning opportunity that each partner affords the other, either intentionally or inadvertently. Yet, providing learning opportunities for one's partner while protecting the core skills that provide bargaining power in the relationship is making transparency a more complicated issue than one could imagine." Further on, Doz & Hamel (1998) state that "firms that manage their transparency well walk a fine line between openness and opaqueness."

Mohr & Spekman (1994) suggest the term *adequacy* to be used in defining the quantified feature. When speaking of the *adequacy* of information sharing, it has also been noticed that the lack of information creates problems. Ring & Van de Ven (1992, 488) state that "the lack of information may be a result of scientific or engineering uncertainty, or a consequence of information asymmetries. Whatever its source, a lack of information also will affect choices regarding the design of transaction governance structure." The lack of information also affects the degree of risk faced by the parties to a transaction. The lack of control is usually accompanied by a lack of information (see MacCrimmon & Wehrung 1986). Ring & Van de Ven

[11] Sahin & Robinson (2002) also use the levels of *full sharing* and *no sharing* of information. Additionally *partial information sharing* occurs between those two extremes.

(1992) noted that the lack of information affects the degree of risk faced by the parties to a transaction on one hand, and choices regarding the design of the transaction governance structure on the other.

Frequency is a further feature of information sharing. Patrashkova & McComb (2004) clarify frequency as the number of messages exchanged. Similarly frequency may be the number of meetings or phone calls, or even accesses to the database. Because frequency does not distinguish between long information-intensive meetings and short email questions, the duration of communication should actually also be taken into account. However, Patrashkova & McComb (2004) conclude in their study that there was actually a striking similarity between the behavior of communication frequency and duration. In other words, communication frequency is indeed a good approximation of team communication activity.

The TCE theory describes contexts and transactions by the following attributes: uncertainty, asset specificity, information asymmetry, and information impactedness. *Uncertainty* stems from intensified market competition and faster technological change, or as Williamson (1989, 45 – cited from Forker & Stannack 2000) noted, “random acts of nature and unpredictable changes in customer preferences.” Moreover, uncertainty can also arise due to inadequate communication between decision makers. Forker & Stannack (2000) cite Williamson (1989) and state that this can occur when one exchange partner is unable to ascertain the coexisting arrangements and intents of others.

Asset specificity is another transaction-related factor explained in the TCE. It refers to the ease with which an asset can be redeployed to alternative uses. The more dependent a firm is on their buyer/supplier, the higher the transaction costs and vice versa. McDonald (1999, 47-48) clarifies the connection between asset specificity and information sharing in the following way: “…high asset specificity increases transaction costs because the quantity and quality of information exchanged between

buyers and sellers increase. High asset specificity can also lead to a dependence situation that can be exploited by powerful partners".

Information asymmetry plays an important role especially in inter-firm interactions. Asymmetry means that parties to a transaction have uneven access to relevant information. In the TCE, *information impactedness* is a term used for the disturbances of information sharing. Information impactedness refers to "a derivative condition that arises mainly because of uncertainty and opportunism, though bounded rationality is involved as well. It exists when true underlying circumstances relevant to the transaction, or related set of transactions, are known to one or more parties but cannot be costlessly discerned by or displayed for others." (Williamson 1975, 31) However, Williamson (1975, 31) points out that "information problems can develop even when parties have identical information."

Finally, when looking at a broader scope of information and when coming to knowledge, yet another qualitative feature is worth presenting: *equivocality*. It was brought forward by Daft & Lengel (1986), who studied the success of knowledge transfer. According to the authors, the equivocality originates from the ambiguity of interpretation of the transferred information (cited from Albino et al. 1999). Equivocality depends on the mental representation shared by the actors involved in the knowledge transfer process in a way that it is generally lower, if the actors operate in the same context and have a common cultural background, cognitive framework and technical expertise (Albino et al. 1999, 55) The equivocality is especially important in the knowledge transfer, which includes the interpretation of the information, but it also highlights the meaning of the similar context of interactants while transferring information.

Summary

The following figure summarizes the features of information and information sharing which came up during the literature review. Usually the quality of information is used

for evaluating the content of information, whereas the quantity of information refers to the media or the style of information sharing.

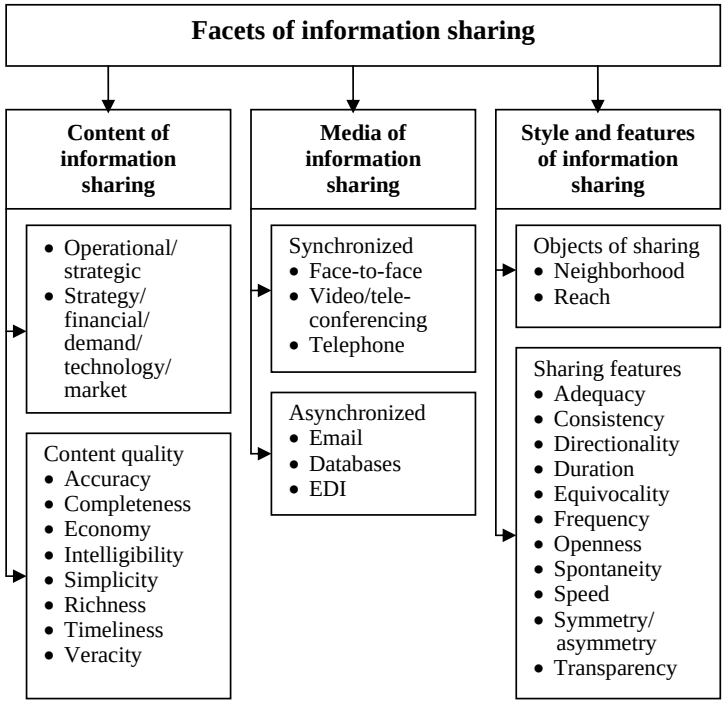

Figure 7. Synthesis of the nature of information and information sharing (collected from Daft & Lengel 1986; Doz & Hamel 1998; Evans & Wurster 1997; Forker & Stannack 2000; Huang et al. 2003; Leung et al. 2003; Lysons & Gillingham 2003; Maltz 2000; McDonald 1999; Mohr & Nevin 1990; Mohr & Spekman 1994; Patrashkova & McComb 2004; Sakthivel 2005; Schurr & Pazer 2002)

The figure above illustrates the multidimensional nature of information sharing. The classification into three main categories was not straightforward, because features could fall under more than one category. For example, the features in the style category are closely related to the content quality. Adequacy, transparency and openness could equally well describe the actual content, but when emphasizing the sharing features and the amount of information, I preferred classifying them under style category.

When considering the nature of information sharing in the R&D collaboration context, some of the features are clearly emphasized. First, the *content* plays a critical role because of the sensitive nature and complexity of R&D information. The sensitivity of R&D information refers to the very essence of company's competitive advantage: what is the core content of their products and what product areas are given emphasis in R&D in the future? This requires decisions about the *openness* (transparency) and *adequacy* of information sharing in particular. Additionally, the adequacy is an important measure, since the lack of information affects the degree of risk faced by the parties to a transaction. These decisions should be evaluated both on the operational level (relating to technical and project information) and on the strategic level (relating to business information).

Secondly, the complexity of R&D information forces a company to rethink their resources, capabilities and processes with their key partners in order to guarantee a smooth process to share and exchange information. Consequently, the features of information sharing *frequency* and other style attributes combined with the right information sharing *media* are emphasized. In terms of frequency it is not essential to count every phone call or email sent, but to evaluate on a general level the work load of information sharing. The frequency of meetings is easier to calculate, since they are often organized according to a certain schedule. Finally, it will be pointed out that the choice of the medium also involves a notion of information richness, which is closely related to the openness and transparency of information sharing.

These features will be further analyzed in terms of context-dependency and when presenting the empirical research results.

3.1.4 Benefits and key concerns

In order to be able to understand the challenging field of information sharing in the network context, the company must be aware of the expected benefits it can gain

when sharing information (or when refusing to share information). Also, the challenges and risks must be recognized both on the level of information sharing and in terms of collaboration.

The benefits of information sharing are easier to understand, if we are aware of the general motives of R&D collaboration. In other words, why to engage in close collaborative relationships in the first place? The benefits of collaboration are listed here shortly since quite a lot research has been done in the field. According to Parker (2000), the motive for collaboration in the R&D field has increased through the increasing complexity of technological and product development, the rapid rate of product obsolescence, and the need to gain fast access to markets. Blomqvist (2002) adds the following motives: i) access to emerging technologies and present opportunities, ii) reducing time-to-market and shorter product life cycles, iii) increased organizational flexibility and responsiveness, iv) increased profitability, v) lesser commitment to risky R&D projects, vi) shortage of scientific knowledge and inability to hire an innovator, vii) inability to replicate the innovative climate of small technology firms, viii) pre-emptive competitive moves, and ix) credibility. Yasuda (2005) continues in a similar vein and reports the main motives to be access to the partner's resources, shortening of the time-to-market, and reduction of the cost. To sum up, it seems that when trying to achieve the above mentioned benefits of R&D collaboration, information sharing must be smooth and efficient[12]. Efficient and smooth information sharing is especially important, since it has been reported that both high and low levels of communication can impede team performance: The problems may be either in the information overload and limited capability to process all information, or in supplying necessary information required in the job. (Patrashkova & McComb 2004)

[12] Efficiency means that information is shared at the right time for the right people with the right content (a similar view is presented by Huang et al. 2003)

When considering information sharing as part of the network management, some strategic level issues are faced. Papazoglou, Ribbers & Tsalgatidou (2000) point out the importance of all partners keeping a clear view of the coherence of the total system of competencies within the network. Specifically, all actors should have an insight as to where and how value is created and what contribution they can make based on their own competencies. Smooth information sharing is clearly a significant means by which to achieve these requirements.

In general, information and communication is said to have an ever-increasing role in the management of networks (see e.g. Gadde & Håkansson 1993; Guinan & Faraj 1998; McIvor, Humphreys & McAleer 1997; Singh 1996), and information is the foundation of management control (Lysons & Gillingham 2003). Rich flow of information should lead to improved learning, continuous improvement, and better development solutions (Sako & Helper 1994). Furthermore, on the strategic level information can act as a way to control and coordinate business relationships and activities performed. Yu, Yan & Cheng (2001, 115) contend that "with information sharing, the decentralized supply chain can achieve the optimal performance under centralized control." Leung et al. (2003) list further advantages of information sharing: information may improve product quality, facilitate new product development, lead to achieve mutual goals, and have a positive impact on adaptation and cooperation.

Thoburn, Arunachalam & Gunasekaran (2000, 248) state: "the way that organisations manage both planned and unplanned events and a rapidly changing economic and trading environment is now becoming a significant success factor." Hence, the authors emphasize the meaning of information systems as a central part of effective management. When arguing on behalf of the crucial role of information, Thoburn et al. (2000) point out the following: "Without information, no business can properly perform any of their required functions. Every business must collect and blend a wide variety of information, distribute and use it throughout its operations, and provide accurate and timely outputs." Wynstra & Pierick ten (2000, 53) claim that

information is used to reduce uncertainty: uncertainty refers to the absence of information, and a typical response to facing uncertainty is to increase the amount of information processing and communication. Finally, Severinov (2001, 547) best describes the fundamental benefit of information sharing when saying that "information must be given in order for it to be obtained."

As it can be seen, there is a wide range of benefits stemming from smooth information sharing. All the benefits highlight the openness of information sharing, although this is also connected with some risks. Accordingly, I shall now present some managerial concerns that relate to the sharing of information. These are combined with the challenges arising in the R&D collaboration contexts. Previously it was concluded that managing information sharing is challenging, since there are many contentual and processual factors (media, style) which have to be included in an appropriate combination in the information sharing strategy. Nevertheless, there are some general concerns that are typical to the information sharing activity.

First, sharing of proprietary information with business partners is often a necessity when doing business. The trend towards partnerships between suppliers and buyers means that buyers are sharing not only product technology, but also process technology to aid suppliers in delivering quality goods on a just-in-time basis. This necessity of open information sharing increases the risk of losing proprietary information. The protection of proprietary company information is one of the most often mentioned risks in R&D collaboration as well. There is also a trade-off between widely disseminated information and protection of information: effective information processing mandates that information is widely available and shared, whereas such wide dissemination can jeopardize the firm's ability to retain proprietary ownership over important information which forms the basis of their competitive advantage (Mohr 1996).

Van de Ven (1994) argues that "unrestricted information sharing in strategic alliance, for example, can make potential competitors stronger by providing them access to

important information." (Cited from Mohr 1996) Leverick & Cooper (1998, 78) have made a similar finding when saying that "the sharing of sensitive information with a partner has already been identified as a danger area in collaboration management." The authors refer to the information as an indication of power. Another issue suggested by the authors is to limit the extent of information exchange to that which is absolutely necessary while still achieving an open and trusting relationship. This dilemma of revealing too much information to the other party highlights the importance of deciding the right level of adequacy and openness, as well as the content and sensitivity of information.

When considering the risks of collaboration, the following issues were put forward: the leakage of firm's skills, experience, and knowledge (Parker 2000), and the risk of divergent aims and objectives resulting in conflict (Tidd, Bessant & Pavitt 2001). Consequently, the complex business environment and the networking of companies create further challenges in information sharing. Circumstances affecting information sharing become significant in complex networks which include different types of companies, resources, and capabilities. This task is even more challenging because of the fact that companies often lack the necessary supplier management capabilities required in the coordination task (Wagner & Boutellier 2002). These challenges become emphasized, since there are some typical problems relating to the management of information sharing especially when considering the perspective of supply management. Such problems include poor guidelines for supplier involvement, integrating suppliers with company systems not implemented correctly, standardization efforts hindered by outdated information, buyer's engineers are not well trained in the supplier's components, and the supplier's output is not incorporated into the design because the buyer engineer does not appreciate the value of the supplier's contribution. (McIvor & Humphreys 2004)

The nature of the R&D context clearly makes information sharing more challenging. Specific challenges arise, because R&D is regarded resource-intensive, expensive, and notoriously risky. Since NPD activities are exploratory in nature, there is usually

a high degree of ambiguity and uncertainty about the knowledge to be transferred. (Cummings & Teng 2003) There is also a fear of losing direct control over the R&D process in the organization, as reported by Parker (2000). Moreover, the changing competitive environment *forces* much more planning, coordination, and review to take place during the design and development process than previously. (Hart & Baker 1994) The challenges related to information sharing are often due to the complexity of information[13], but also due to the complexity of the environment where information sharing takes place. Finally, information sharing is found challenging also because it is so strongly related to "people issues" and culture, as stated by Ruggles (1998, cited from Jarvenpaa & Staples 2000).

This section has illustrated the challenging field of R&D collaboration, and what the role of information sharing is in it. The following figure summarizes the main findings.

[13] The problem and challenge in information sharing is described by Feldmann & Müller (2003), who argue that in the situation of divergent interests associated with asymmetric information, the question of how to ensure a beneficial decision-making for the whole system supply chain arises.

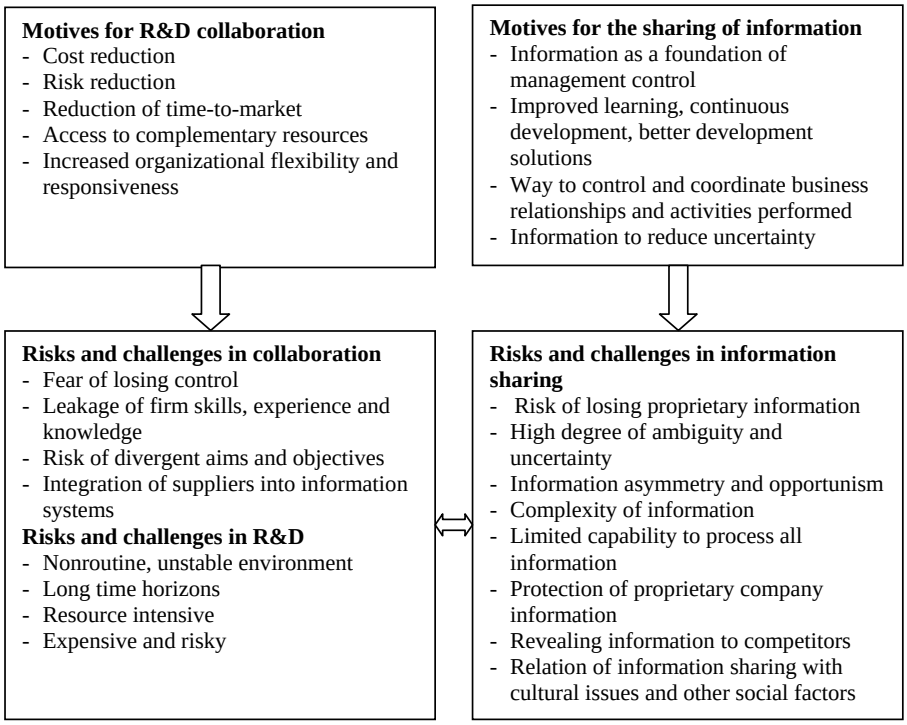

Figure 8. Synthesis on the nature of information sharing in the R&D collaboration (collected from Blomqvist 2002; Cummings & Teng 2003; Hart & Baker 1994; Jarvenpaa & Staples 2000; Lysons & Gillingham 2003; McIvor & Humphreys 2004; Mohr 1996; Parker 2000; Patrashkova & McComb 2004; Sako & Helper 1994; Tidd et al. 2001; Wynstra & Pierick ten 2000; Yasuda 2005)

As we can see, we are dealing with a challenging field: already collaboration is found difficult and the benefits are sometimes hard to show, and when collaborating in the field of R&D, the task becomes even more challenging. When considering the risks and challenges arising in the information sharing activity, we are confronted with a very complex phenomenon: managing information sharing in R&D collaboration. However, there are several means by which to respond to these challenges and risks. Some of these practices relate closely to the general supplier management, whereas other means deal with R&D project management. Above all, in order to gain the benefits from the collaboration, and to make the whole process efficient and smooth, far more attention must be paid to the management of information sharing. As a

consequence, some of the best practices or success factors that have turned out to be significant in managing information sharing will be highlighted next.

3.1.5 Success factors

First the factors related to information sharing will be presented, and after that attention will be paid to the success factors specific to R&D collaboration.

The implementation of a successful and smooth information sharing process clearly requires well-defined information sharing strategies. Kärkkäinen (2002) explains the need for information sharing strategies through the developments in networking and increased complexity in the companies' environment. This leads to the increasing dispersion of information. These factors force companies to develop more flexible information sharing approaches instead of individual companies carrying on storing information in company databases or in paper-based files. Another factor is that more strict governmental requirements on product life cycle management, traceability, and after-sales support are emerging. Accordingly, companies are forced to retain increasing amounts of product-related data and also to amend it as the product advances or is repaired or inspected. (Kärkkäinen 2002)

According to Luomala et al. (2001, 55), the information strategy includes such issues as who is responsible for the development of information management, how, and by which resources, and what information is common to all members in a network, what is personal, or not systematic. Patrashkova & McComb (2004, 85) contend that "effective communication requires that team members select the most appropriate medium for the information transfer and communicate the optimal amount of information in order to achieve top performance." Huang et al. (2003) maintain that the core question in the sharing of information is how to share the right information at the right time in the right format by the right people under the right environment in a way that maximizes the mutual benefits of the supply chain as a whole. In general,

strategies of information sharing should be considered in terms of what information to share and how and with whom to share it (by who, which could be seen as part of the question *how*). The information sharing strategy should also consider the level of visibility or transparency of information, as noted in the studies by Childerhouse et al. (2003), Feldmann & Müller (2003), and Mohr (1996).

The research stream of R&D management brings about further practices that have been found useful in managing information sharing in R&D collaboration. For example, Ragatz, Handfield & Scannell (1997, 197) state the following about successful technology sharing: "confidentiality and non-disclosure agreements are widely used to help address technology ownership issues, but mutual trust and strong business relationships are key to making technology sharing work." Particularly, the relationship history and reputation clearly help in managing the risk inherent in sharing information openly. Moreover, Ragatz et al. (1997) found a lot of other practices, some of which were more critical than others in managing information sharing (direct, cross-functional, inter-company communication, and customer requirements information sharing were the most often mentioned critical factors).

Blomqvist et al. (2004) claim that today the management of networked R&D requires an integrated R&D strategy consisting of firm-specific and path-dependent dynamic capabilities. Additionally, strong collaboration with a range of business partners (large global partners, small innovative suppliers, venture capitalists, standardization authorities, governmental authorities, and customers) is a prerequisite. This calls for coordination of cross-functional and cross-border activities, thus emphasizing both internal and external collaboration.

Because NPD efforts are often pursued by strategically allied partners, the success factors in NPD also relate to critical success factors of strategic alliances (Ragatz et al. 1997) The success factors include, among other things, equity sharing, trust, co-location, asset specificity, information sharing, joint sharing of new technology, cost savings sharing, and the length of a buyer–supplier relationship. Sivadas & Dwyer

(2000) list the following factors: the spirit of candor, teamwork, and reliance among members of different units, cross-functional cooperation, proper coordination, and trust[14]. Parker (2000) has found similar success factors in his study, and reports the most critical success factors such as trust between collaborating partners, frequent consultation between participants, consultation between marketing and technical personnel, and shared benefits. In addition transparency, openness, honesty, and full disclosure of all necessary information were mentioned in the study. On the contrary, frequent communication turned out to be problematic at the same time, because some people felt that too much time was used for communication (meetings, etc), as Parker (2000) points out. In summary, the following list includes some means in order to overcome the challenges and risks of information sharing in R&D collaboration.

Table 3. Success factors when facing challenges and risks in information sharing and R&D collaboration

Issue	Success factors
Information sharing strategy (Kärkkäinen 2002; Luomala et al. 2001; Huang et al. 2003)	Well-defined strategies and decisions concerning what, to whom, how, and when
R&D strategy (Ragatz et al. 1997; Blomqvist et al. 2004)	Direct, cross-functional inter-company communication, customer requirements information sharing, NDA practices, integrated R&D strategy, strong collaboration
Alliance/partnership success factors (Ragatz et al. 1997; Sivadas & Dwyer 2000; Parker 2000)	Trust, co-location, asset specificity, equity sharing, information sharing, joint sharing of new technology and cost savings sharing, length of a buyer/supplier relationship, spirit of candor, teamwork, reliance among members of different units, cross-functional cooperation, proper coordination, frequent consultation between participants and consultation between marketing and technical personnel, shared benefit, transparency, openness, honesty, and full disclosure of all necessary information

Jensen & Harmsen (2001) bring forward the fact that the previous studies about NPD success factors are fairly consistent, but only a few companies have *implemented* these identified factors. The reasons for poor implementation are many: i) companies have not been able to implement the normative advice the researchers often suggest, ii) there is a lack of operational, normative implications or they are brief, and iii)

[14] According to Sivadas & Dwyer (2000), information may be withheld because of the lack of trust.

there are general barriers to change. In fact, the authors claim that the implementation issues have not been addressed in the literature (except Cooper 1990). Consequently, the authors suggest an alternative way of filling this missing link in the implementation of NPD success factors: they link the *competence theory* with the NPD literature success factors. (Jensen & Harmsen 2001)

This leads us to emphasize the *capabilities* of both companies, and therefore, the theoretical background of dynamic capabilities have found reasoning to be highlighted in the management of information sharing. Moreover, the resource-based view helps to see information as a resource, the transaction cost economics will reveal the circumstances that explain the general governance mechanisms, and the traditions in Supply Management (supply chain management and industrial marketing and purchasing) will be presented in order to stress the significance of context-dependency.

3.2 Prerequisites for managing information sharing

In this section the importance of managing information sharing is revealed in the light of existing theories. Information is regarded as a resource, which leads us to consider the Resource-Based View (RBV) of the firm. Information sharing as an activity is related to the Transaction Cost Economics (TCE). Finally, managing these resources, activities and capabilities required link information sharing to the Dynamic Capabilities (DC). Consequently, these theories provide the basis for understanding the role of information sharing in the business in general. Otherwise the above-mentioned theories are not included in the core of analyzing the context-dependency of information sharing.

The firm's capacity to renew their resources (such as information), knowledge (skills), and routines (such as information sharing) are found relevant in the firm's competitive advantage in changing operating environments. This renewal ability is

called *dynamic capabilities*. In other words, *dynamic* refers to the ability of the company to create new asset combinations, and *capability* means the resources, processes, and structures of the company which are required in the asset base development and organizational transformation. (Teece, Pisano & Shuen 1997)

Dynamic capabilities are one of those viewpoints that better explain the complexities and dynamics of technological change and innovation. According to Blomqvist et al. (2004, 594), "dynamic capabilities also gives a strategic perspective to managing R&D activities." Teece et al. (1997) approach uncertainty and asset specificity through the concepts of *appropriability regime* and *complementary assets* as the fundamental determinants of the choice of coordination structures related to the organization of R&D. Appropriability regime refers to the protection of knowledge assets, which is emphasized in networked R&D.

Svahn (2004) successfully describes three types of business nets and the capabilities that are required in each type. Since the empirical case of the present study deals with the *business renewal nets* instead of *current business nets* or *emerging business nets*, the required capabilities in business renewal will be explained more thoroughly. Management capabilities require both internal capabilities of the company, as well as external capabilities. Business renewal nets aim at efficiency and effectiveness by fostering local product, production-technology or business process innovations, and modifying the existing routines and capabilities. Moreover, according to Svahn, the exploration and exploitation of knowledge becomes the key capability, which requires an open, trusting culture, partnering orientation, and strong interaction skills of the personnel working in the cross-functional teams. Also, the skill to evaluate partner competence becomes important. Furthermore, integration and coordination capabilities are required to manage the complex business nets successfully. (Svahn 2004)

Consequently, information as a resource is closely related to the dynamic capabilities. According to the capability theory, the generic and idiosyncratic capabilities form the

foundation for the competitive advantage of the firm. So-called meta-capabilities are required in order to create, coordinate and orchestrate resources and basic capabilities for the changing business environment. (Jantunen 2005, 25) These dynamic capabilities thus explain how significant it is to manage the R&D resources and capabilities in the changing environment, such as in the telecommunication sector.

Information can be seen as a *resource* a company possesses. The resource-based view proposes that organizations have a mix of resources available, and the success of organizations results from variances in resource portfolios and how those resources are used. For example, higher performance is sustainable when the differentiating resources are relatively scarce and cannot easily be copied, acquired, or substituted. The resource-based view emphasizes the VRIN attributes (valuable, rare, inimitable, and non-substitutable) of physical, human, and organizational resources which contribute to the sustainable competitive advantage (Barney 1991). According to Palmberg & Martikainen (2003, 5), the RBV "is useful for interpreting the conditions conductive for the exchange, absorption and appropriation of knowledge, and hence also touches on issues related to the stability and success of strategic R&D alliances." In the R&D collaboration context, information clearly is a resource necessary to the teams participating in R&D. The RBV also suggests that management capabilities related to information adoption and use will be important in the success of new product development. (Zahay et al. 2004)

The concept of transaction cost economics has been used in explaining the range of *activities (transactions)* in which the firm engages itself. TCE offers us an analytical device that makes it possible to understand why firms engage in markets, vertical integration (hierarchy), or networks (partnership) when acquiring necessary capabilities needed for the efficient supply chain organization. In other words, the company makes the fundamental decision between *make or buy*. In this study the starting point is to focus on collaborative relationships between the focal company and their key R&D suppliers, in particular, when the decision about buying has been made. The applicability of the TCE is mainly in its framework to analyze

circumstances in which coordination mechanisms develop. Williamson (1975) regarded transaction costs as organizational failures, which were due to environmental factors (uncertainty and small number of potential trading partners), transaction-related factors (frequency and asset-specificity), and human-related factors (bounded rationality and opportunism).

McIvor (2003, 381) clarifies the *bounded reality* in the following way: "The rationality of human behavior is limited by the ability of the actor to process information." *Opportunism* occurs when "people are prone to behave opportunistically which means self-interest seeking with guile," as McIvor (2003, 381) put it. The hazards of the inequality of information distribution between the buyer and the seller are that such inequality may give one party an advantage over the other, or alternatively, cause considerable confusion due to incomplete knowledge. Frequency, asset specificity, and uncertainty as well information asymmetry and impactedness were introduced already in the style of information. Figure 9 summarizes the key issues arisen from the theoretical background in the governance of information sharing.

Dynamic capabilities

- Meta-capabilities are required in order to create, coordinate and orchestrate resources and basic capabilities
- Appropriability regime refers to the protection of knowledge assets
- Complementary assets are used to facilitate learning, transformation and integration of resources and knowledge

Resource-based view

- Information as a critical resource of the company
- Recognition of the valuable, rare, inimitable, and non-substitutable physical, human and organizational resources

Transaction cost economics

- Circumstances and transaction attributes to explain different coordination mechanisms
- Sources of transaction costs: environmental factors (uncertainty and small number of potential trading partners), transaction-related factors (frequency, asset specificity, information asymmetry, information impactedness), human-related factors (bounded rationality and opportunism)

Figure 9. Key issues in managing information sharing stemming from the theoretical background (collected from Barney 1991; Teece et al. 1997; Williamson 1975)

In sum, dynamic capabilities are required in order to create, coordinate, and renew the company's resources, processes, and structures in the changing environment. The resource-based view of the firm helps us to understand the nature of information and how it is considered as a resource a company possesses and utilizes. Furthermore, the transaction cost economics is used to analyze the activity of information sharing, its features, and governance mechanisms. However, these theories and above-mentioned success factors do not provide a comprehensive understanding of the extent to which information sharing activities and means of governance are influenced by the circumstances they are applied in. As a consequence, in this study the issue of context-dependency as a means of governance has risen up, since it has been claimed that information sharing – like any other networking activity – must be evaluated and practices created in the right context. Far too often some means are launched as best practices, although trying to introduce and apply those practices suitable in one business is very unlikely a recipe for success in a quite different business environment. The reason for this is simply that companies have different properties which require specific and appropriate treatment if the circumstances (i.e., supply networks) differ from each other. Therefore, there is a need to understand and analyze the surrounding business environment and circumstances in the companies more profoundly, which leads to the introduction of the concept *context-dependency*.

3.3 Response of context-dependency in managing information sharing

This section provides arguments for choosing context-dependency as a response to managing information sharing and gives a short introduction to the basic research traditions in the field of Supply Management.

3.3.1 Concept of context-dependency

Since the research context is R&D *collaboration*, the supply management's research tradition will complement the challenging field of managing information sharing. The study considers supply management from the viewpoint of context-dependency. The compound is made up of two words of which, according to the Merriam-Webster dictionary, *context* means "the interrelated conditions in which something exists or occurs" (also environment, setting). *Dependency*, on the other hand, refers to dependent, which is "determined or conditioned by another" (also contingent). In other words, context-dependency means something (here information sharing) which is determined by a set of interrelated conditions (here the R&D collaboration).

It is generally known that one essential part in the management is the alignment of the interaction and practices in the right context. Context-dependency is taken as a key issue in information sharing, since "Information and knowledge are only useful in specific situations" (Lueg 2001). It is traditionally accepted that a company has to understand their business environment and adopt their operations to that, but it is obvious that when collaborating with other companies an understanding of this context becomes more complicated.

In a similar vein, Olkkonen, Tikkanen & Alajoutsijärvi (2000) contend that complex interaction phenomena (like information sharing) occurring in the networks or relationships should be addressed on organizational, departmental and personals levels. That is, the focus is not merely on the interactions, but also in understanding of the situational factors of it. Also, Cox (1997) emphasizes the role of understanding context-dependency. He states that it is important to understand the appropriateness of the suggested solutions through two types of analysis: first of all, to understand why and in which circumstances certain models or tools or processes are applied, and secondly, to consider also which are the appropriate tools to be used in the first place. It is not only the matter of past events and understanding of those, but, even more

importantly, also of being able to consider the effects these circumstances and events have on future.

Moreover, Cox criticizes strongly the value of benchmarking: what is beneficial for one company may not be applied to another – the prevailing circumstances must first be understood and then there is a need for developing the appropriate tools and practices to guide operational practices. Later on, Cox (1997) claims that the key determinant of success will not be the knowledge that these collaborative ways of working exist, but whether or not the individual understands why it is appropriate to enter into them in the first place, and for what purposes. Appropriateness means doing such things, which can be achieved within the circumstances which actually confront us.

Pettigrew (1997, 340) also states that it is important to analyze "how the outer and inner contexts surrounding firm level processes shape this process. Outer context includes the economic, social, political, competitive and sectoral environments in which the firm is located." Inner context refers to the inner mosaic of the firm; the structural, cultural and political environments which shape features of the process. Moreover, Pettigrew (1997) highlights the fact that processes are embedded in these contexts and can only be studied as such.

The concept context-dependency is closely related to what is understood by *embeddedness*. According to Nicholson & Sahay (2004, 331), "embeddedness research has been able to establish that economic and organizational activities are embedded with larger and more complex social processes that shape and are shaped by human activity." This approach clearly emphasizes the cognitive levels and factors stemming from the behaviors of humans. Such factors are for example the culture and language. However, due to the research perspective selected for the study, these social and behavioral factors are given less emphasis in the study.

Another important approach relating to the context-dependency is the *contingency approach*. Zeithaml, Varadarajan & Zeithaml (1988, citing Wright & Ashill 1998) contend that the contingency theory has its roots in systems theory. It views the effectiveness of an action as being dependent on the relationship between the action in question, and other elements of the system, especially the environment with which the system interacts. As pointed out by Wright & Ashill (1998), "contingency theory recognises that solutions are situational rather than absolute, and that they may become inappropriate under different environmental conditions. A key application of contingency theory is the long standing recognition of the importance of matching information processing to environmental variety." The contingency approach clearly speaks for the context-dependency to be taken as a starting point when analyzing the means of governing information sharing. However, in this study the contingency approach is not followed: instead, the basis for studying context-dependency derives from the supply management literature.

3.3.2 Research traditions in Supply Management

The primary research traditions of Supply Management are presented now, because they serve as a starting point in the analysis of networks and relationships.

There are two schools[15] that have been developing the concept of supply network: largely descriptive research on industrial networks conducted by the Industrial Marketing and Purchasing School (IMP), and the more prescriptive research on Supply Chain Management (SCM), which is based on strategic management, operations management and logistics (Lamming et al. 2000). These schools of supply

[15] Additionally, the concept of value network has recently established a position among network researchers. A value network combines the advantages of a traditional network and value chain activities. The former emphasizes joint efforts when achieving efficiency, whereas the latter focuses more on the value-creating activities. Also, the role of information exchange is highlighted in the value networks (see e.g. Parolini 1999; Bovet & Martha 2000).

management provide frameworks for analyzing the contexts of networks and relationships, as well as interactions between these.

The supply chain is the basic unit in *supply chain management*. However, today the supply chain is too narrow a perspective to describe the complexity of the business environment that companies enter. Thus, the term *network* comes to place. The term *supply network* has emerged from SCM research, and it reflects a holistic and strategic process of supply, while going beyond immediate relationships (Lehtinen 2001, 26). The term *network* in supply chain management reflects an attempt to make the latter wider and more strategic by harnessing the resource potential of the network more effectively than competing firms (Lamming et al. 2000). Moreover, most supply chains are actually networks, since there always are external players and elements that have an influence also on the specific chain. For example, Lamming et al. (2000) define the supply network as a set of supply chains which together describe the flow of goods and services from their original sources to their end users. The term 'network' is intended to imply a more strategic concept in line with the idea that networks compete with networks, rather than simply firms with firms.

According to *Industrial Marketing and Purchasing*, networks can be understood in different ways. Basically the differences between terms are not remarkable, but they express the various emphasis areas in the particular network. *Business network and industrial network* are terms mainly presented by IMP researchers (Ford et al. 1998; Gadde & Håkansson 2001). The IMP-driven research approach has moved from the interest in the original nature of the dyadic relationships (also knows as interaction approach) to the dynamic development of dyadic relationships, and later to the *network approach* (Olkkonen et al. 2000). Furthermore, according to Olkkonen et al. (2000), the dyadic relationship has to be seen in the context of a larger set of interfirm relationships. The rationale of the IMP group is to understand the actions of the buyer and seller and the longitudinal development of their relationship.

It seems that there are differences in the concept *network* among researchers: Operations strategists and the SCM school tend to regard product or service supply networks as sub-networks nested within the inter-organization networks and having more tangible operations. IMP researchers, on the other hand, focus more clearly on these inter-organization networks and the total set of activities of firms. In the end, it could be stated that those supply networks are easier to control than less tangible exchanges of IMP networks (Harland & Knight 2001).

3.3.3 Summary

In this study the concept *network* is used in the context where the impacts of information sharing become apparent both in the dyadic relationships and within the larger R&D network. The supply network and supply chain management perspective gives an emphasis on managing supply, which differs to large extent from the R&D activities. The IMP-driven network perspective is useful especially when structuring the network, although the IMP group takes a holistic view to understanding the activities of the whole networks. However, in emphasizing the interaction approach, the ideas and frameworks presented by the IMP group are valuable in this study. Context-dependency is related to one form of managing a supply network, namely, information sharing which was presented earlier in this section.

Information sharing is regarded as a one-way action from the focal organization to the suppliers. Understanding the resources and capabilities relating to this activity is the key issue from the management viewpoint. Consequently, a company has to analyze the interaction process and other factors relating to the relationship and generic business environment. Also, when collaborating with suppliers or other partners in the network, a company faces a lot of challenges relating to the exchange or sharing of information. They have to decide the appropriate level of information (content) in order to avoid information overload or leakage of significant information. These decisions include choices of adequacy and openness, among other things.

Additionally, in order to achieve a smooth process of information sharing, decisions concerning the medium and style of activity must be made. What kind of information is shared with a certain medium, and with which frequency? Which practices are found critical in the given circumstances? These questions must be in line with the supply network characteristics in question, and that is where the context-dependency of information sharing comes to place.

Accordingly, the sharing of information and its context-dependency provide a good starting point for analyzing its management in the supply network. The context-dependency and means of governance of information sharing were taken as key words in this study, because the Author wanted to emphasize the strategic essence of information sharing over the operational one. To sum up, the information sharing strategy is understood as one element in the supply network strategy, which expresses the ways in which the network could be managed.

4 CONTEXT-DEPENDENCY OF INFORMATION SHARING

The purpose of this chapter is to present a framework which can be used in the analysis of context-dependency. First the focus is on a larger context, namely general network analysis and how it can support the study of context-dependency. An a priori framework for studying context-dependency of networking activities will be generated by combining the existing taxonomies, models and other elements of networks and relationships. Furthermore, previous research in the field of context-dependency of information sharing will be examined in the light of the proposed framework.

4.1 Analyzing networks and relationships

Networks can firstly be analyzed in different ways: emphasis can be put on structural issues, which consider the actors (i.e., companies) and their positions in the network. Secondly, an analysis of the resources owned in the network is another way to approach networks. For example, the R&D information possessed by different parties is part of resource analysis. Thirdly, the activities performed between the actors provide a path to analyze the network. Information sharing as a resource and activity was mainly explained and analyzed in the previous chapter, but this chapter incorporates it into a larger framework that reveals the context-dependency.

In general, network research has typically been done on different levels. A well-known classification of the level of analysis is provided by Harland (1996). She suggests that these levels are networks, external chains, dyadic relationships, and internal chains which are illustrated in the figure below.

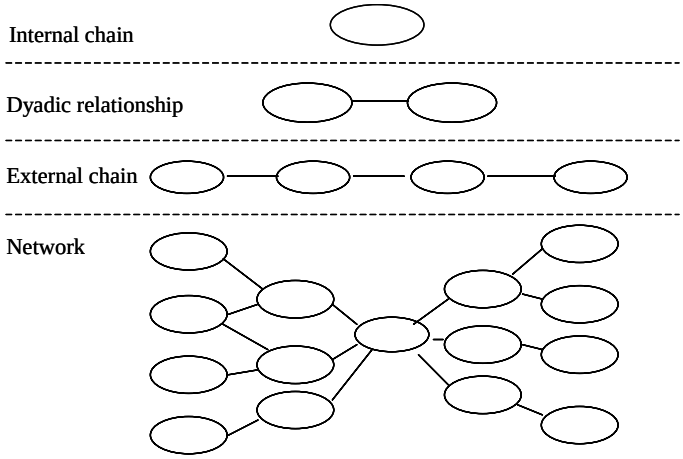

Figure 10. Levels of research in supply chain management (Harland 1996, 72)

Although the empirical study has been conducted in the context of three dyads between the focal company and their R&D suppliers in each R&D program, the network perspective cannot be ignored. It is essential to understand the bigger picture around dyadic relationships, since the actions taken during the R&D process and in two-way transactions have further impacts on the other suppliers in the network. Of course, the analysis on the level of a company (internal chain in the Figure 10, and so called focal company in this study) is also essential when considering the information sharing activity, and especially management of it. The limitation in the research framework introduced by Harland (1996) is, however, that it still does not give an understanding of processes and activities occurring in the network. Therefore, it is worth looking at the ideas presented forward by the IMP group.

The IMP group considers a network[16] to consist of actors, resources, and activities, and this research stream emphasizes especially the dependencies and relationships between the actors (Ford et al. 1998; Gadde & Håkansson 2001). Accordingly, analyzing networks becomes difficult, as the activities performed between two

[16] The network itself expresses a complex view of several *nets*, as noted e.g. by Möller et al. (2002).

players influence other activities performed between other players. In sum, the following framework is used to illustrate different elements required in the network analysis according to the IMP group.

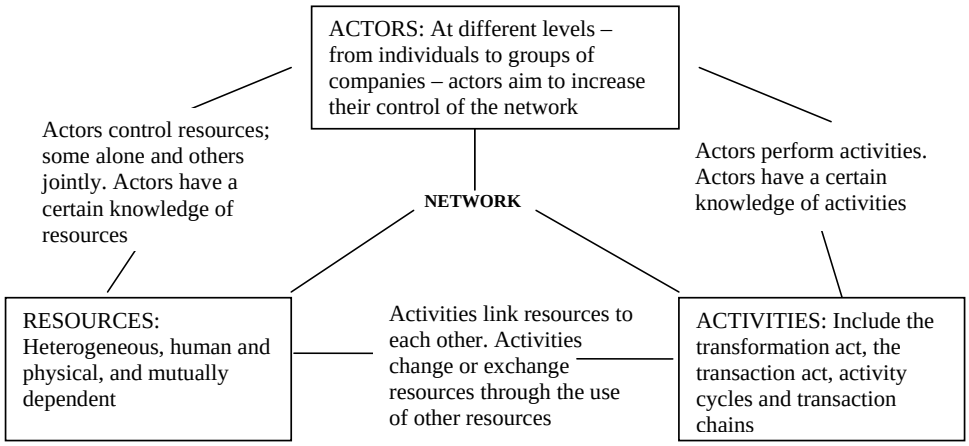

Figure 11. The key concepts and ARA – a theoretical model (Håkansson 1987)

The ARA model is a good framework for describing networks in that it expresses the activities and resources as part of the picture. The ARA model is similar with the terms that Allee (2003) uses in her value network analysis. According to her, the core activities or processes are identified as the exchange. The exchange activity is mapped by identifying transactions in which something flows between participants as a tangible or intangible deliverable. In other words, participants are actors, transactions are the activities or flows, and deliverables are the resources, the object of transaction, or activity.

Next, the taxonomies and models that are applicable for the analysis of context-dependency will be presented. As it was concluded in this section, the framework should consider both the level of analysis from the network level to the individual company, and the resources the actors possess and activities they perform.

4.2 Existing models for describing networks and business relationships

So far a couple of researchers have tried to generate a framework by which an analysis of networking activities and interactions can be made. I shall now review the models by Albino et al. (1999), Wagner & Boutellier (2002), Möller & Wilson (1995), and Olkkonen et al. (2000). These taxonomies and models serve as a starting point in the process of generating a modified framework for studying context-dependency which provides a good basis for the purpose of this study.

Ideas presented by Albino et al. (1999) provide a detailed framework. The authors have studied the knowledge transfer process, which lays emphasis on the individual capabilities of processing information. The framework is partly applicable also in the context of information sharing, because it takes into account the content and media in addition to the actors and other contextual factors. According to the authors, an analysis framework should consist of the following components: 1) the actors involved, 2) the context where interaction takes place, 3) the content transferred between actors, and 4) the media by which the transfer is carried out.

The context is further divided into internal and external contexts. The internal context corresponds to the organizational culture, and features like behavior, technical skills and technology assets, meaningful attitudes and values belonging to and shared by the members. Whereas, the external context can be defined as a set of variables representing the conditions in which inter-organizational relationships take place. Such factors include the market structure, its national/international scale, firm cooperation, closeness, expectations and socio-cultural aspects. (Albino et al. 1999) The content factor proposed in the framework is interesting. The authors define the content of knowledge transfer to be the ability to perform a specific task. This viewpoint is clearly different from what is understood as the content of information sharing in R&D collaboration. On the other hand, content when understood as the object of exchange (or sharing) is considered to be an element in the media where

Albino et al. (1999) distinguish between code and channel. The former is information and the latter is the means by which the code is transferred.

Wagner & Boutellier (2002) have a much narrower approach. They consider the relationship level only and recognize two main areas: internal and external issues. Internal issues involve product, technology, and competence; whereas external issues take into account the industry environment, the market, the competitive situation, and the economy. This study differs from the others in a way that contextual factors are embedded in the relationships, whereas for example Albino et al. (1999) handle these separately (internal/external contexts).

The IMP group places more emphasis on relationships and activities between the actors. The benefits of IMP-driven network analyses are that they take into account the relationship level in more detail. One well-known classification in this respect is provided by Möller & Wilson (1995), who extend the actor element of the generic ARA model to comprise the larger environment of buyer–seller relationships. As a result, the authors introduce a taxonomy of factors in buyer-seller interactions[17], which is illustrated in Figure 12 on the following page. This taxonomy seems to be appropriate for illustrating the information sharing activity between the focal company and their R&D suppliers, since it shows the interaction processes as a separate element. The classification by Möller & Wilson also considers the different organizational levels in more detail and from a different point of view than, for example, Albino et al. (1999). Also, task characteristics and outcomes of interaction are highlighted. The figure below presents the skeleton of an exchange relationship, whereas the dyadic interaction model that Möller & Wilson (1995, 35) bring forward, include more specified characteristics of each elements in the taxonomy.

[17] Allee (2003) points out a notion related to this discussion when stating that “these knowledge and other intangible exchanges are not just activities that support the business model; they are part of the business model.”

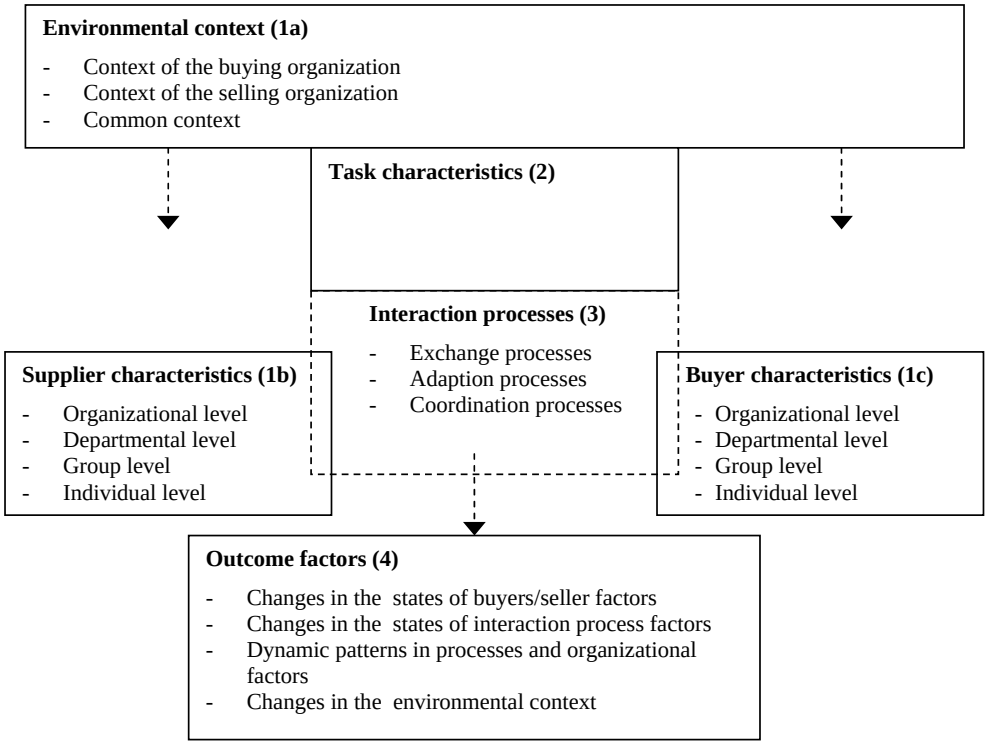

Figure 12. Taxonomy of factors in buyer–seller interactions (Möller & Wilson 1995, 25)

The environmental context characterizes the markets and society where the focal business exchange takes place. A distinction can be made between the environmental context of each interactant and their common context. In general, the environmental context is characterized e.g. by demand capacity and dynamics, production capacity, technological dynamics, and number of buyers/suppliers. The environmental context is further divided into the buyer and supplier characteristics. These can be analyzed on four levels: 1) organizational, 2) departmental, 3) group, and 4) individual. The skills, experiences and assets as well as attitudes and values belong to the company-level characteristics. Because this study focuses on analyzing organizational rather than individual factors, such characteristics are placed on the organizational level,

which actually belong to either one. For example, capabilities can be regarded both organizational and individual where organizational capability refers to the ability to possess, retain and develop the capabilities the individuals have. Additionally, other organizational characteristics include the interactant importance, relative dependence, expectations (goal compatibility, behavior, equity), and comparison level alternatives (expected costs/benefits and risks). The task characteristics refer to the objects of interaction, and they could involve the following items: dimensionality of exchange, technical complexity, innovativeness, importance (financial, end-product, production process), exchange frequency, or substitutability. (Möller & Wilson 1995)

According to Möller & Wilson (1995), the core of the business exchange relationship is formed by the processes through which the focal tasks of the exchange are carried out. The interaction process is divided into three sub-processes, which are 1) the exchange process, 2) the adaptation process, and 3) the coordination process. The exchange process can be captured through episodes which refer to actions or outcomes of actions performed by the organizations or their representatives. Thus, an episode has a specific content and time frame. The adaptation process refers to the modification of resources or their ways of operating, the realization of which can lead to adjusting resources, skills, operations, goals, attitudes, and managerial values. (Möller & Wilson 1995) According to Halinen (1997), the adaptation process includes the history of the relationship, the experience and values, as well as the patterns of behavior. Coordination refers to the development and use of mechanisms that facilitate the control of exchange processes, as Möller & Wilson (1995) put it.

The last element in the interaction process deals with outcome factors. According to Möller & Wilson (1995), these outcomes could be changes in the states of buyer/supplier factors, in the interaction process factors, or in the environmental context, among other things.

In line with the Möller and Wilson taxonomy is the conceptual framework presented by Olkkonen et al. (2000). According to them, relationships and networks are

essentially formed in interpersonal communication processes, which are affected by their contextual and structural factors. This emphasizes not only the role of individuals in the communication process, but in particular the understanding of situational factors. The framework is illustrated below:

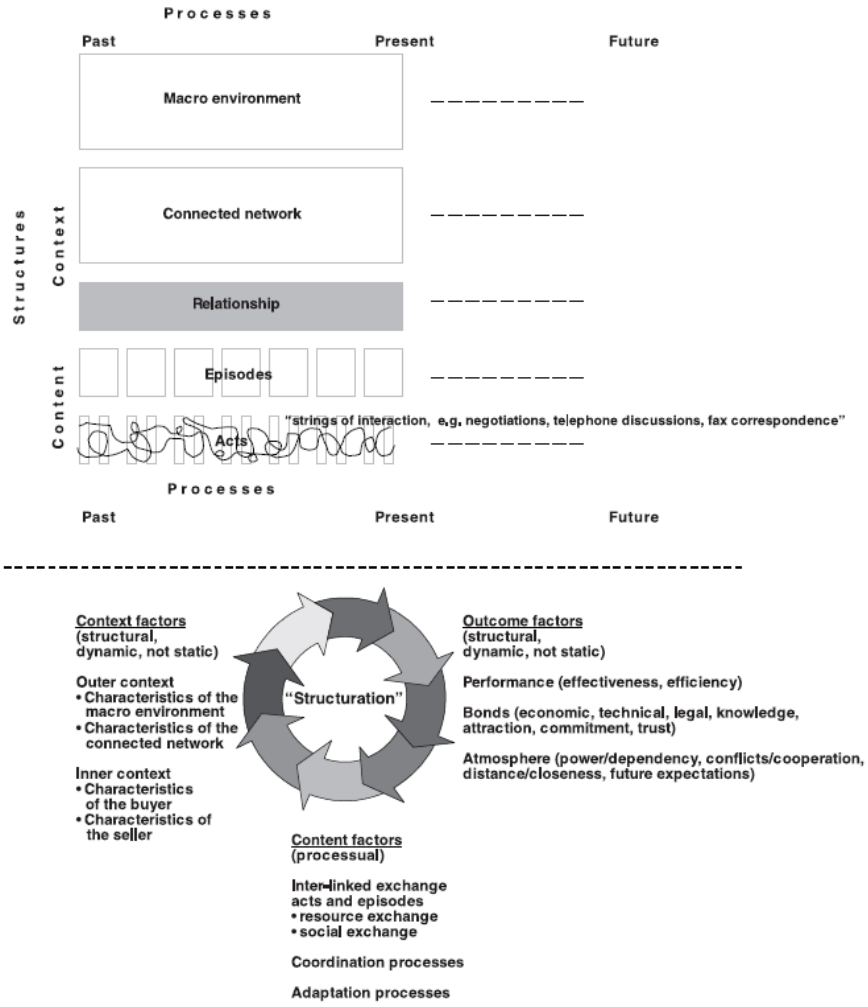

Figure 13. A conceptual framework for understanding the role of communication in business relationships and networks (Olkkonen et al. 2000, 406)

As we can see, the lower part in Figure 13 is closely related to the taxonomy presented by Möller & Wilson. However, Olkkonen et al. want to emphasize the dynamics of the relationships, which needs to be captured through inter-linked acts and episodes. They also elaborate the framework with communication interaction, which is closely connected to the present study. The authors also consider *relationships* as a separate factor: this is not clearly shown in the Möller & Wilson taxonomy.

All in all, for the purpose of this study the available models revealing context-dependency provide a good basis, but these will be modified. Expressly, the aim is to provide a comprehensive framework that takes into account the different levels required in both the network research and the interaction approach as introduced by Möller & Wilson (1995) and Olkkonen et al. (2000). Therefore, the existing models are supplemented with other elements covered in Supply Management.

4.3 Towards an a priori framework for analyzing context-dependency

At this point the basic levels of network research have been overviewed. The main levels of the contextual elements are those of network, chain, relationship, and company. In addition, the IMP group offers additional emphasis on the activities and resources the companies exchange and possess in the network. Next, these models will be supplemented with other important elements found in the supply management literature on networking activities and network research.

4.3.1 Elements of context-dependency

When studying the elements of context-dependency, we move from the network level to the company level. When creating the taxonomy of supply *networks*, Zheng et al. (1997) and Lamming et al. (2000) distinguish the following contextual variables: i)

market environment, ii) product and process, iii) network structure, and iv) focal firm network strategy. This taxonomy does not go beyond networks, but it provides good elements for the network level analysis. Lehtinen (2001) follows the taxonomy of Johnsen et al. (1998) and Lamming et al. (2000), even though she has classified the supply network variables in more detail, as illustrated in the figure below:

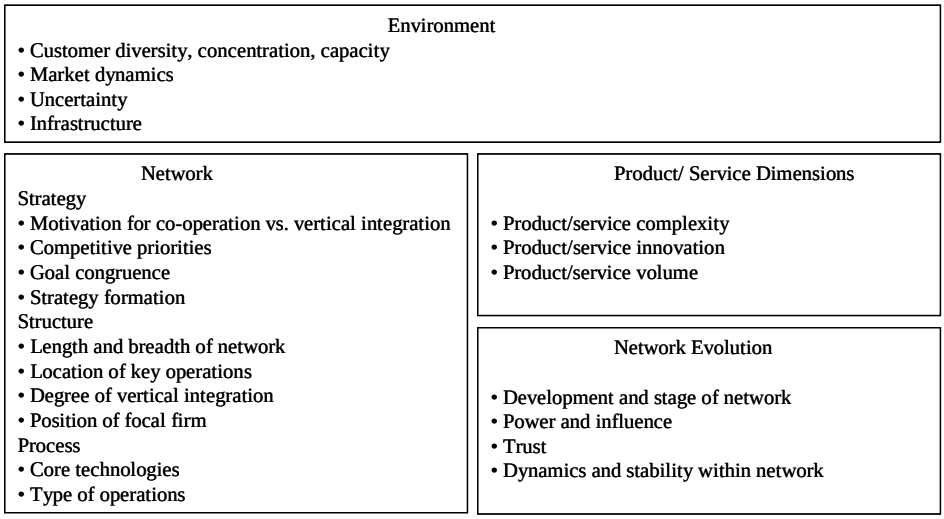

Figure 14. Supply network variables (Lehtinen 2001, 28)

The overview of supply network variables that Lehtinen (2001) describes above provides an extensive framework for analyzing networks. Environment issues can be called external network variables, while strategy, structure, and processes are mainly internal factors, but also part of the environment. When considering the context of the present study, the environmental variables cannot be ignored, as the telecommunication sector is known for market dynamics and uncertainty. This means that many of the variables are common to different business units, for example, the general company strategies and the business environment. Network-related factors have been divided into strategy, structure, and process, from which the process factors are also closely related to product factors. Network evolvement analyzes the

specific factors that are important on the relationship-level, as well (trust, as an example), but in the following, the chain and relationship specific factors (dyadic relationships in the model by Harland 1996) will be presented separately.

The *chain level* factors are comparable to those on the network level. Moreover, since it has been stated that dyadic relationships display the whole network, the supply network variables also match on the *relationship level*. Additionally, the classification principles of relationships are important to clarify, because some relationships are more strategic or close than others. In general, the relationships vary from short-term, arm's length relationships to strategic partnerships (Patterson, Forker & Hanna 1999). Wagner & Boutellier (2002) distinguish two opposite relationships: discrete and relational exchange, where the former one is equal to arm's length relationships and the latter is closer to partnerships. According to Wasti & Liker (1997), the buyer–supplier relationship characteristics can be as follows: 1) level of competition in the supplier market, 2) the supplier's dependence on the customer, 3) performance monitoring activities assessed to the degree that the customer repeats the supplier's prototype tests for verification, and 4) relationship history. Croom, Romano & Giannakis (2000) state that important variables influencing relationships between the actors in the network are: i) the sourcing strategy, ii) the attitude and commitment to collaborative improvement programs, iii) the positioning of the focal firm within the total network, iv) the extent of dependencies on the network (proportion of a supplier's business), followed by the longevity of the relationships, the technological or process links, the existence of legal ties, the degree of power and influence of each party, and the length and complexity of the chain.

Knight (2000) lists key features of the relationships, according to which the relationships between partners can be evaluated. These features are: importance (e.g., strategic), inter-dependence (e.g., mutuality, technology-based, commercially-based), longevity (time in years), character of relationship (adversial, collaborative), contractual relations (partnering, performance related), and complex interface (the number of individuals involved, the degree of integration).

The studies by Johnsen et al. (1999), Lamming et al. (2000) and Lehtinen (2001) propose that product characteristics should be included in the supply network analysis. Indeed, the *nature of the product* seems to be a significant factor affecting networking activities. Fisher (1997) is one of the often cited authors explaining the relation with the impact of product characteristics on further activities in the supply networks. According to Fisher (1997), a knowledge-intensive product (also innovative product) requires different kinds of decisions than a functional product, as the former must be more market responsive, the demands are more difficult to forecast. Additionally, innovative products have shorter product life cycles, and complex network structures which especially in the upstream of the supply chain shift the emphasis on the management of information. The opposite of an innovative product is the functional product, which is characterized by long product cycles and stable easy-to-forecast demand. (Fisher 1997) Of course, some innovative and unique products are also of lower complexity.

Möller & Wilson (1995) introduce *task characteristics* as one element in their taxonomy. In the context of this study the development work given to the R&D supplier is considered a task. Task characteristics as reported in Sobrero & Roberts (2002) are asset specificity, means uncertainty, and goals uncertainty. Asset specificity determines the extent to which the activities performed in the relationships have some economic value per se. The level of task uncertainty can be referred to the action or the goal domain. In the first case there are several options by which to achieve the goal. In the latter case the goal itself is unclear.

General models for studying the contexts and activities of networks and relationships have now been presented. These models have been supplemented with other elements inherent in the networks. As a consequence, it is now possible to generate a framework in which the context-dependency of networking activities can be studied.

4.3.2 A priori framework for studying context-dependency

Harland (1996) introduces different levels on which networks can be approached. Depending on the research focus, network research can be implemented on the levels of company, dyadic relationship, supply chain or the whole network. Studies by Zheng et al. (1997), Lamming et al. (2000), Harland et al. (2001) and Lehtinen (2001) add important elements to the network level analysis, and for example the product characteristics are given extra emphasis in comparison to the work by Möller & Wilson (1995). Albino et al. (1999) regard actors as individuals, and the relationship factors are presented as part of the external context (firm cooperation).

The dynamic interaction model proposed by Möller & Wilson (1995), later supplemented by Olkkonen et al. (2000), is used to structure the wide range of elements required in evaluating information sharing in the R&D collaboration context. These models were chosen as a basis for this study partly because of their illustrative credits, and more importantly, because they explain clearly the relation between environmental contexts, company-specific issues and task characteristics in the interaction process. Also, the idea of dividing organizational factors into several levels seems to be useful when analyzing the R&D collaboration context in terms of R&D programs, business units, and Business Area levels. However, these two models have a couple of limitations that must be taken into account.

First, the relationship-specific features do not exist as such in the original taxonomy introduced by Möller & Wilson: they are embedded in the exchange processes (for example the relationship history is part of the adaptation process). Nonetheless, considering the impact of dyadic relationships in the network as suggested for instance by Harland (1996), it is relevant to present relationship factors as a separate element. Secondly, in the original taxonomy the adaption and coordination processes were handled as part of the interaction, and this viewpoint is understandable if we look at the holistic nature and development of the buyer–supplier relationship.

However, because this study only considers the role of information sharing in the buyer–supplier relationship, this exchange (sharing) process is highly dependent on the other two processes. Therefore, the adaptation and coordination processes could actually be handled as contextual factors. For example, sufficient guidelines and the level of control belong to the coordination process in the original framework, although they are closely related to the R&D program in question. Thus, this unit is the appropriate place where to analyze the impacts of coordination efforts on information sharing.

The interaction process, namely, information sharing is supplemented by elements presented already in the previous chapter (see Section 3.1.3). To be more precise, the content, media and style are described during the different episodes of interaction. The dynamic aspect was highlighted also by Olkkonen et al. (2000).

This study does not place great emphasis on the outcome factors, unless there are clear causalities between certain actions and reactions. A profound analysis of the outcome factors would probably require a longer period of observation and more profound analysis of the causes and consequences.

These modifications in the original taxonomy presented by Möller & Wilson (1995) have now been made, and this a priori framework is used when presenting the context-dependency of information sharing and later the empirical research results.

To summarize, the following figure illustrates the a priori framework modified from the models presented by Möller & Wilson (1995) and Olkkonen et al. (2000), as well as by Albino et al. (1999), Halinen (1997); Harland et al. (2001); Lamming et al. (2000); Lehtinen (2001); Wagner & Boutellier (2002) and Zheng et al. (1997). Also, some of the elements required in the analysis are included in the frameworks of Wasti & Liker (1997); Croom et al. (2000), and Knight (2000).

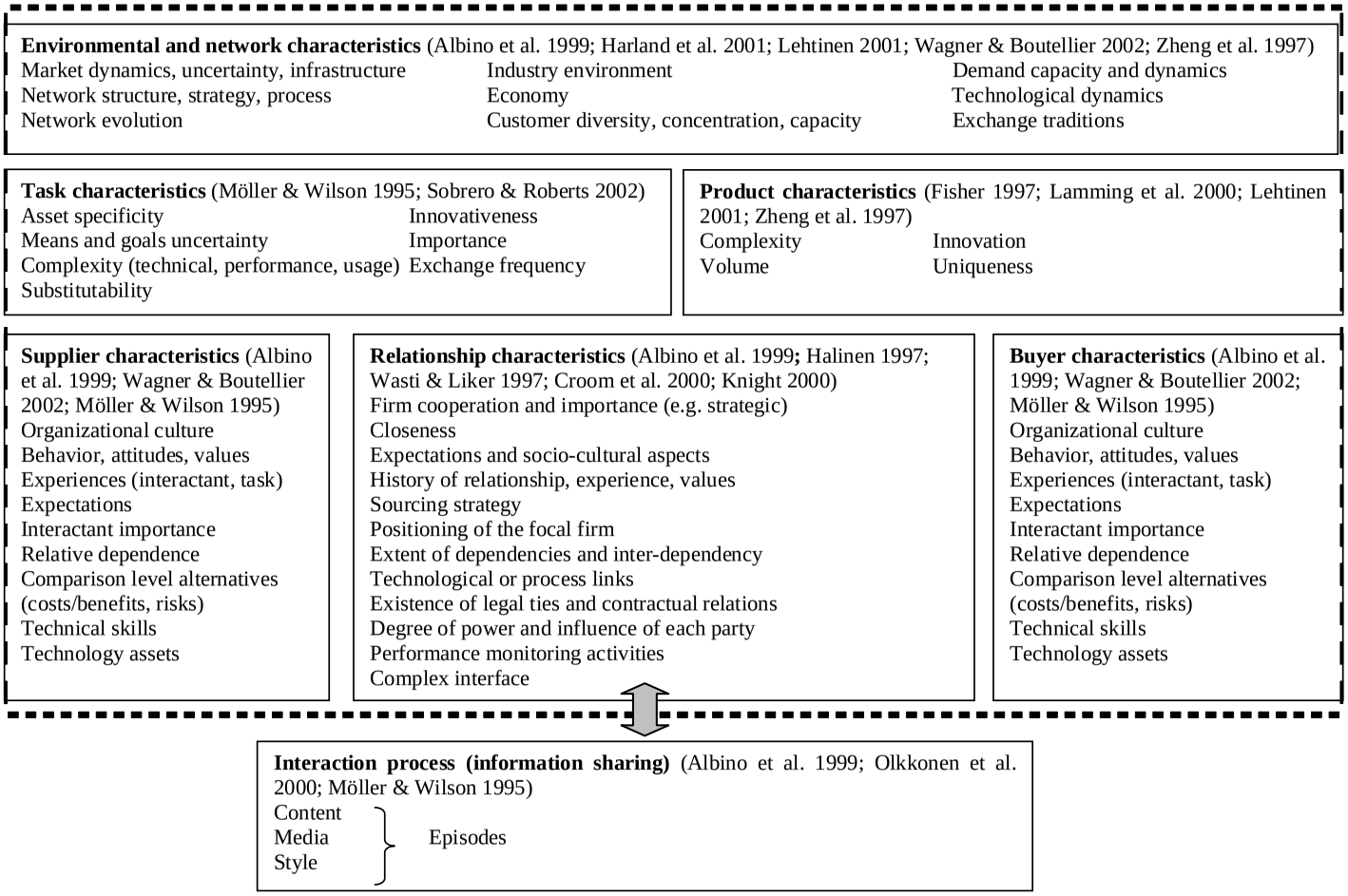

Figure 15. A priori framework for analyzing the context-dependency of networking activities

A priori framework in the light of the present study

Here, the environmental context refers to the specific features of the telecommunication sector, the technological dynamics where information sharing interaction takes place. Also, the features of the whole R&D network, the number of suppliers, etc should be taken into account. When moving to buyer characteristics, the organizational level represents the Business Area level. The focal company as a whole is not taken as a starting point, because the Business Areas differ quite a lot. Furthermore, the departmental level means the different business units within the selected Business Area. The group level is analyzed through the R&D programs. Because of the limitations of the present study, the individual level is not in the core focus of the study. Still, it cannot be totally ignored due to the importance of social interaction embedded in communication.

The characteristics of each R&D supplier will be evaluated as well. However, since the interviews were implemented in the focal company, some supplier-specific characteristics may not be visible. Therefore, only those supplier characteristics are emphasized, which became most evident in the focal company. The R&D program is divided into smaller management units called projects, and the R&D supplier typically participates in these R&D projects.

In the context of this study the R&D collaboration between the focal company and their R&D suppliers represents the business exchange relationship. The focal task is defined in each R&D program and is typically a development of either a software or a hardware product, where the supplier is given certain tasks (e.g., some features or parts of the product to be developed). The interaction process refers to information sharing during the R&D phase. To be more precise, information represents the resource which is exchanged, thus carried out and controlled in the interaction process.

The content and media as well as the interaction style (e.g., openness and frequency) form the basic process of information sharing. This process can be divided into the

exchange of resources (thus R&D information) and social resources. The focus is merely on the exchange of resources, although the exchange of social resources cannot be ignored, since it refers to human communication (Möller & Wilson 1995). The interaction process can be divided into episodes. In the present study the episodes of interaction process are the certain phases in the R&D process; they could be the R&D supplier's involvement in the specifications phase, in the implementation phase (e.g., programming or design) or the testing phase. In the empirical part these episodes are called planning, production, and delivery, and they represent the beginning, middle and end of the R&D program. In R&D collaboration the adaption process includes the length of the relationship, and the level of trust, among other things. The R&D supplier's participation in the previous R&D programs clearly improves the experience and capability of the R&D supplier. These features are presented in the characteristics of the supplier.

In this study the coordination efforts are the guidelines generated for collaboration in general (including the supplier management process: supplier selection and supplier involvement, among other things), guidelines concerning the R&D process (e.g., list of documents required at different phases of the process), and guidelines concerning the communication policy (what does "company confidential" mean, what kind of visibility could be given to the supplier, etc). As found out by Katz (referred from Brown & Eisenhart 1995, 367–368), "teams with a short history together tend to lack effective patterns of information sharing and working together." Thus, the relationship history has an influence on the guidelines and procedures of information sharing, which in turn has a direct influence on the success of information sharing.

4.4 Current understanding of the context-dependency of information sharing

Up to this point a priori framework for studying context-dependency of networking activities is proposed and explained in the context of this study. Before introducing the empirical research findings, the current understanding of the context-dependency

of information sharing – a specific form of networking activities – is presented. To be more precise, the review of the literature has shown that the context-dependency of networking activities has been recognized and to some extent relations between information sharing and contextual factors have been identified. However, there is room to analyze more thoroughly the context-dependency of information sharing. In fact, this issue has been studied so far especially in the marketing channel literature (see e.g. Mohr & Nevin 1990; Mohr, Fisher & Nevin 1996; Lamont et al. 2000).

4.4.1 Previous research

Industry and market

In the study by Harland et al. (2001), the authors found out that the dynamic environment[18] has an influence on the activities performed in a network (see also Mohr & Nevin 1990), especially the strong effect the dynamics aspect had on demand management, and thus, on information processing. Mohr et al. (1996) recognize that communication becomes more important in a high-speed industry (like the computer industry) because of the technical nature of the products, rapid technological change, and dynamic competitive environment. Lamont et al. (2000) have concluded that communication strategies are very dependent on conditions outside the channel, such as competition and regulation.

Network

On the network level the *roles and positions in a network* must be taken into account. However, because this study deals with the focal company and their R&D suppliers only, attention is paid to the importance of these positions and the roles of the focal company and the subcontractor or system suppliers, thus excluding the analysis of the

[18] Harland et al. (2001) contend that two measures for the supply network dynamics can be used: operations process characteristics and market conditions. The former was measured in terms of process variety and volume whereas the latter was measured in terms of frequency of new product launches, number of competitors supplying similar products, and ease of switching.

first and second tier suppliers[19]. According to Harland, Brenchley & Walker (2003, citing Henders 1992), network position can influence access to the resources of other network members, reputation, and expectation. Furthermore, Koon & Low (1997) discovered that a firm's network position spells out the actor's opportunities and limitations in establishing, maintaining, and terminating business relationships. To be more precise, when controlling some unique resource within the network, the company may be able to strengthen its existing relationships, thus using power in the network. Accordingly, a position is a location of power to create and/or influence business relationships, and this leads to considerations that information sharing can be controlled when having a strong position in the network.

One of the main influential factors in the network is the role of the *focal company* (see also Lorenzi & Baden-Fuller 1995: strategic centres; and Doz & Hamel 1998: nodal positions), where one company takes a hub role in the network structure. Moreover, the strategic center is responsible for value creation for their partners as well as being a leader, role setter and capability builder (Lorenzi & Baden-Fuller 1995). According to Doz & Hamel (1998), the nodal firm is more than an information clearinghouse; they develop a vision and business concept and provide guidance and legitimacy in assigning roles and in defining governance rules. The unique resources and competencies that the nodal positions usually possess are also the basis for their influence and power. Hines (1994, 67) states: "Within the tiering structure it is the responsibility of the customer tier to organize, communicate with and nurture the level below." Lamont et al. (2000) also regard channel complexity, behavioral aspects of the bases of power, and conflict levels as influential factors affecting communication.

In this study the Case Company is regarded as the focal company in their R&D network. To be more precise, when analyzing each program, the business unit and R&D program managed by the focal company serve as the nodal position. The R&D

[19] See for example Hines (1994) and Lamming (1993) for the tiering structure of the suppliers.

supplier acts as a system supplier, since they may have own subcontracting as well (especially in the case of hardware design and production).

Relationships

This study has taken close, collaborative relationships as its starting point. That is, it has been generally approved that information sharing and communication are more intensive in collaborative relationships (e.g. Bensaou 1999; Ellram 1991; Rice & Hoppe 2002). According to Rice & Hoppe (2002), in the low level alliances information sharing is passive, whereas middle level alliances entail active coordination of logistics, and high level alliances entail intimate sharing of information, knowledge, and resources. Baiman & Rajan (2002) argue that "the amount of information exchanged among subcontractors is what really distinguishes supplier networks from more traditional arm's length relationships." Finally, Virolainen (1998) has recognized the role of information sharing and communication with the supplier not only as a critical success factor, but also as a reason for the failure of partnership. Expressly, two-way information sharing and early communication with the supplier were regarded keys to a successful partnership, while the most important single reason for a failure in a partnership was poor communication between the buyer and the supplier. (Virolainen 1998, 207)

McDonald (1999) presents a four-fold classification of supplier relationships which is a synthesis of definitions used in the literature. It also brings about the role of information in these relationships. The classes are i) the traditional approach (arm's length relationship), ii) the monitoring approach (arm's length with close monitoring), iii) the supplier development approach (cooperative relationship with limited monitoring and enhanced information exchange), and iv) the partnership approach (cooperative relationship with very limited monitoring and two-way information sharing, joint problem solving, etc). This classification obviously connects the amount of information exchange with the strategic importance of the relationship.

Bensaou (1999) studied the portfolios of relationships, and obtained information about different aspects of each relationship: 1) the component and its technology, 2) competition in the upstream market, 3) the supplier itself, 4) the nature of the boundary spanner's job, 5) the internal workings of the relationships (the contractual conditions, the social climate, and the extent and type of information exchange within the relationship), and 6) the performance of the relationship. According to Bensaou (1999), information sharing varies from "narrow-band," limited, and sparse to the broadband, frequent, and "rich media" exchange typical of strategic partnerships.

Moreover, information sharing intensity has also been studied in the new product development (Wynstra & Pierick ten 2000). The authors combine the type of supplier involvement and communication practices. In the case of strategic development, communication is characterized as "two-way traffic," rich media such as face-to-face group meetings, high in amount, and functional disciplines are diverse.

Arguments for some of the implications are clearly easier to make. As an example, the use of information systems is more common in the close relationships, because the long-term commitment to the relationship is a rationale for investing in common information systems. This point is related to the discussion of the manageable number of relationships: a small firm cannot invest in many different systems required by different customers. On the other hand, the focal company's interest is to create a common system for all their suppliers and partners in order to avoid costs arising in the system investments. (Huhtinen et al. 2003)

Company

According to Davenport, Eccles & Prusak (1992), an unstable organization operating in an uncertain business needs as much information as possible about the environment and their own performance. The authors have taken information management as a starting point and developed five models of information politics. The study contributes to recognizing different conditions under which certain information sharing practices are appropriate. Accordingly, especially organizational

climate seems to affect information politics: the more unstable the organization operating in highly uncertain business, the more information should be exchanged.

Mohr & Nevin (1990) continue with *climate*. Some of the characteristics studied as part of climate are leadership style, job variety, job autonomy, organizational identification, psychological environment, attitude towards management, goal compatibility, domain consensus, evaluation of accomplishments, norms of exchange, and mutual trust. As a result, communication will vary, depending on whether the channel climate is high or low in trust and mutual supportiveness. In other words, communication with higher frequency and more bi-directional flows, informal modes, and indirect content is used in a channel with a high degree of trust.

Group

The specific nature of the NPD process leads to the statement that information required in the NPD and the management processes that produce knowledge for NPD can be viewed as a multidimensional environment: it consists of both external and internal information and uses rich as well as flat methods to share and store information, and multiple approaches to sharing information throughout the organization, NPD teams in particular. (Zahay et al. 2004) Information may be used to reduce task-related uncertainty, and equivocality stemming from multiple interpretations from a given set of data. Project complexity increases the information needs of NPD team members by increasing both uncertainty and equivocality. Teams reduce these factors by continuous interaction; disseminating information throughout the NPD process reduces uncertainty and integrating information across functional sources reduces equivocality. (Zahay et al. 2004)

Individual

Albino et al. (1999) regard openness, trust and prior experience as the key features which have an influence on efficient knowledge transfer. These features are equally significant in the information sharing process. Additionally, there are a couple of

characteristics that clearly have an impact on information sharing. Such factors are, for instance, culture and language (Daft & Lengel 1986).

The reason for showing only few elements on the individual level influencing information sharing is probably due to the research tradition followed in this study: the supply management perspective mostly considers the elements on a group or a company level, whereas social exchange theories (e.g. social cognitive approach which for example Albino et al. (1999) follow) focus more on the factors stemming from the individual level.

Product

Another influential factor in information sharing is the nature of the *product.* For example Bensaou (1999), Lamming et al. (2000), Lamont et al. (2000), and Li & O'Brian (2001) have made such conclusions in their studies. Lamming et al. (2000) have found out the connection between *information sharing and the type of product and the management of network*. According to the authors, the product type is an important factor, which also affects the nature of information and information sharing. In fact, the characteristics arisen in networks and relationships are in close relation to product types. As an example, Johnsen et al. (1999) noticed the link between the complexity of the product in terms of the number of the components, the size of the upstream supplier network, and the complexity of processing information throughout the network. Johnsen et al. (2000) use the following items to describe product complexity: component process complexity/time, component complexity, component variety, component uniqueness, component innovation, and component value. These factors were analyzed on a scale low–medium–high.

Novak & Eppinger (2001, 189) state the following: "...greater product complexity gives rise to coordination challenges during product development." Along with coordination challenges, information is expected to be shared more frequently. Bensaou (1999, 41) combines the information sharing strategy together with product characteristics by stating that the "complexity of the product requires the exchange of

detailed information on a continuous basis, justifying the high level of communication…" Bensaou (1999) has listed items that define product characteristics specific to strategic partnerships. Some of these features are i) degree of standardization or customization, ii) amount of new technology, iii) innovation leaps in technology, process or product, iv) amount of frequent design changes, and v) amount of strong engineering expertise. Additionally, in the strategic partnerships the product is close to buyer's core competency.

Tasks

According to Keller (1994), nonroutine and unanalyzable technologies (i.e., task technology) would require a high amount of information processing for effective performance, and vice versa. Keller refers to Daft and Lengel (1984, 1986) when pointing out that the amount and richness of information processing and the communication media used should be appropriate to the level of task uncertainty. As reported in the study by Sakthivel (2005), it is obvious that knowledge-intensive tasks need co-presence, proximity and face-to-face interaction from the group members. Moreover, increased task interdependence in a group process will increase the interaction frequency.

4.4.2 Summary

The review on the context-dependency of information sharing has now taken place. The following table summarizes elements that obviously have an influence on information sharing.

Table 4. Studies on the context-dependency of information sharing and communication

Element of network research	Main factors influencing information sharing	Author(s)
Industry	Dynamic environment	(Harland et al. 2001)
	High-speed industry: technical nature of the products, rapid technological change, and dynamic competitive environment	(Mohr et al. 1996)
	Competitive issues	(Mohr & Nevin 1990)
	Competition or regulation	(Lamont et al. 2000)
Network	Positions in the network, usage of power	(Doz & Hamel 1998), (Harland et al. 2003), (Hines 1994), (Koon & Low 1997)
	Channel complexity, behavioral aspects of the bases of power and conflict levels	(Lamont et al. 2000)
Relationships	Strategic alliances, collaborative relationships	(Baiman & Rajan 2002), (Bensaou 1999), (Ellram 1991), (Forker & Stannack 2000), (McDonald 1999), (Mohr & Nevin 1990), (Rice & Hoppe 2002)
	R&D collaboration & strategic development	(Wynstra & Pierick ten 2000)
Company	Capabilities	(Teece et al. 1997)
	Organizational climate	(Davenport et al. 1992)
	Leadership style, job variety/autonomy, organizational identification, attitude towards management, psychological environment, goal compatibility, domain consensus, evaluation of accomplishments, norms of exchange, and mutual trust	(Mohr & Nevin 1990)
Group	R&D project complexity	(Zahay et al. 2004)
Individual	Openness, trust and prior experience	(Albino et al. 1999)
	Culture, language	(Daft & Lengel 1986)
Product	Innovative/complex product	(Fisher 1997), (Lamming et al. 2000), (Lamont et al. 2000), (Li & O'Brian 2001), (Novak & Eppinger 2001)
	Number of components, component process complexity/time, component complexity/variety/ uniqueness/innovation/value	(Johnsen et al. 1999)
	Degree of standardization or customization, amount of new technology, innovation leaps in technology, process or product, amount of frequent design changes, amount of strong engineering expertise	(Bensaou 1999)
Task	Nonroutine and unanalyzable technologies, task uncertainty	(Keller 1994)
	Knowledge-intensive tasks, task interdependence	(Sakthivel 2005)

The first notion is that most studies have identified the relationship and product characteristics as the dominant factors affecting information sharing. For example, the studies focusing on the level of company are rather few, and the subject is dominated by the study of Mohr & Nevin (1990). Of course, this may be a consequence of limiting the literature review to the studies to the field of Supply Management: it is obvious that relationship-specific issues are highlighted in this research stream.

The a priori framework of factors identifying the context-dependency of networking activities already introduced a lot of factors that are not evident in the information sharing interaction. As it was stated in the taxonomy by Möller & Wilson (1995), the company level characteristics could be divided into four levels which certainly include different kinds of factors. Furthermore, based on the table presented above, it does not become clear, what kinds of characteristics are emphasized in the buying (focal) company versus the supplier. Consequently, this raises a question *whether there are new factors arising in the context that have an impact on information sharing.*

Secondly, it is remarkable, that very often researchers are satisfied when pointing out the causality between the information sharing action and the predominant characteristics of the environmental factors. In some cases the impacts on information sharing are described more frequent or more extensive information sharing, but the other attributes describing interactions within the relationships are unclear (Mohr & Nevin 1990). Additionally, Moberg et al. (2002, 767) contend that "while the proposed merits of increased information exchange appear sound, the literature provides little empirical support for the importance of information exchange or the characteristics and practices that will lead to increased exchange." Therefore, this study claims that *there is room to analyze more in depth how the contextual factors influence the content, media, and style of information sharing.*

Yet another remark from the current understanding of the context-dependency of information sharing deals with the means that could be used in the management of a network. In the previous chapter a list of success factors and other practices were introduced, but it is highly unclear, *what the linkage of these practices within the given circumstances, namely, the means of governance is.* To conclude, the following approach has been taken as a starting point, when moving towards the empirical case:

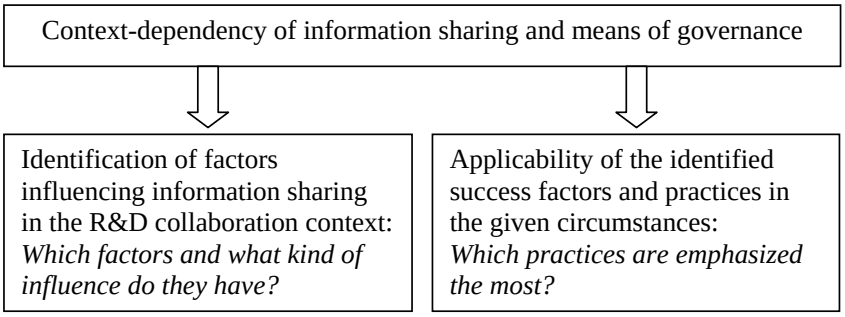

Figure 16. Revealing the context-dependency and means of governance of information sharing

In the identification of the R&D collaboration context, attention will be paid to the following factors according to the a priori framework: i) common factors including the industry and network levels, ii) buyer-specific characteristics, iii) supplier-specific characteristics, iv) relationship-specific characteristics, v) product characteristics, and vi) task characteristics. The company-specific characteristics are further divided into four levels, namely, organization, department, group, and individual. When analyzing the impact of those contextual factors on information sharing, the content, media, and style will be described in the different episodes of the R&D collaboration process. Last, the means to manage information sharing activities in R&D collaboration will be considered and placed in the prevailing circumstances.

5 EMPIRICAL RESEARCH

This chapter presents the results of the interviews implemented in the Case Company. The objective is to create preliminary understanding of factors which have an influence on the sharing of information in R&D collaboration. Also, the success factors required in the governance of information sharing will be highlighted. This chapter is mostly descriptive, but it has explanatory features since it aims to explain the relations between the context and the nature of information sharing. Due to the wide area of research (incl. the environmental factors of the case as well as the nature of information sharing and means of governance), and the stress to analyze the causes and consequences of these factors and means, the relations between different items will be described rather deeply. However, in the end of each section summaries of the main issues will be provided, generated as the Author's interpretation. All in all it can be said that the role of the Author has been merely that of a reporter instead of an analyzer or an interpreter, which role is taken in Chapter 6.

The chapter is organized as follows. First, an overview of the empirical research setting will be provided. It will lead the reader to the case, to the R&D process in general, and to three Sub-Cases. The motivation and drivers behind the interaction will be explained in the second section. The purpose is to explain why the focal company ties collaborative relationships in the field of R&D, which requires extensive information sharing with the suppliers. Then the nature of the information sharing process will be described. In the subsequent sections each element of the contextual factors in the a priori framework will be presented: 1) environmental context, 2) buyer characteristics, 3) supplier characteristics, 4) relationship characteristics, 5) product characteristics, and 6) task characteristics. Finally, the chapter will deal with success factors and other means of governance in information sharing arisen in the interviews.

5.1 Introduction to the empirical research setting

The Case Company can be defined as a supplier of mobile, broadband, IP (Internet Protocol) network infrastructure and related services. The Case Company owns the brand of the products being bought from the supply market, which emphasizes their role in the network. This company has taken along many smaller suppliers in engineering, electronics, and the metal industry. The Case Company consists of several Business Areas, but this study focuses only on one of them (called Business Area X). This choice is based on the fact that the Business Area in question is large, and there is a great variety of products within it. The Business Area which is in the focus of this study is characterized by project-based production instead of mass production. There are three business units in this Business Area, and one R&D program was selected from each business unit. Next, the general R&D process of the Case Company, as well as three Sub-Cases will be introduced.

Research and development process

In the Case Company, R&D activities are performed in R&D programs. The program's mission is to "produce the desired end result to meet the defined specifications, and within the allocated time and financial resources." (Case Company Material 2005b). One program consists of several sub-projects, which can be either R&D projects or others, such as quality assurance or customer documentation.

In this study the R&D program is divided into three main episodes or phases, which differ slightly from the five phases defined by the Case Company. This was justified because, firstly, there is no need to go through the phases in too much detail, and secondly, the intention is to avoid revealing the Case Company's R&D process. In fact, it is assumed that making a difference between the beginning, the middle and the end provides enough distinction between the phases for analytical purposes. Additionally, there is a so-called pre-planning phase, where many important decisions are being made in terms of the R&D program. The following figure illustrates the

R&D program in different phases or episodes (the episodes are based on information gained from the Case Company Material 2005b).

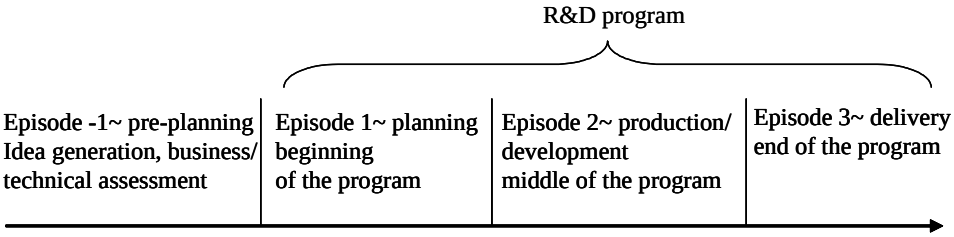

Figure 17. Phases of the R&D program in the study

Episode -1 comprises the following two phases presented in the literature: 1) idea generation, and 2) business/technical assessment. This episode has been left out of the study due to the following reasons: i) the R&D program was not yet thoroughly defined, ii) issues on information sharing were restricted only to a small number of company's own staff, meaning that information sharing was already well-controlled, and iii) suppliers were not included to great extent in this episode. Nevertheless, in this study information sharing issues were also dealt with in Episode -1, if they impacted further actions in Episodes 1–3. Episode 1 includes the planning of the program, and the program will begin with full resources. In Episode 2 the main development or production tasks are being done. In Episode 3 the product is prepared for larger production. To sum up, Episodes 1–3 represent the R&D process from the beginning of the program till the end of it.

Before conducting the empirical research it was assumed in the discussions with the Case Company advisors that information sharing during Episodes 1–3 was easier than in the pre-planning phase. This could be assumed, because there already existed the idea of a product being developed. However, the R&D process was regarded challenging, because the *specifications and standards adjust and develop* during the program. This creates challenges, for example, in the field of change management and decision-making. These challenges are further increased in the *collaboration*,

when also the questions of proprietary information sharing come to place. In addition, the challenges are emphasized when the program begins, because *a large number of people become involved*. Therefore, the limitation of the study to the above-mentioned three episodes is well justified.

Next, the three Sub-Cases of the study will be presented shortly.

Sub-Case 1

Sub-Case 1 developed a hardware/software product, and the program was the biggest among the three Sub-Cases. It consisted of several projects (or development tasks), from which two R&D project managers (referring to Task 1A and Task 1B in the Appendix 8) were interviewed in addition to other program interviews. The organization of the program differed from the other two programs in a way that the R&D projects were constituted of the phases of the R&D process, thus being a phase program. The R&D supplier in this program was Finnish. The program was carried out in several sites in Finland and additionally in one European country.

Sub-Case 2

Sub-Case 2 was a software program. The program was middle size when comparing to other two programs. It consisted of several R&D projects, from which one project manager and two sub-project managers (referring to Sub-Project 2A and Sub-Project 2B in the Appendix 8) were interviewed. The program was organized as a waterfall model, which means that a certain feature of the product was implemented and tested before the next implementation and testing. The R&D supplier in this program was Asian, and the program was carried out in several sites in Finland and additionally in two sites in one Asian country.

Sub-Case 3

Sub-Case 3 was a hardware program. The program size was small in comparison to the other two programs. It consisted of several R&D projects, from which two project managers (referring to Project 3A and Project 3B in the Appendix 8) were

interviewed. The R&D supplier in this program was Finnish. The program was carried out in several sites in Finland, and in contrast to the other Sub-Cases, the R&D supplier was located in the same city as the rest of the program team.

In sum, the main differences between the Sub-Cases were

- The culture of the R&D supplier (either Finnish or Asian)
- The location of the R&D supplier (either in the same city in the same country, in a different city within the same country or in a different country)
- The product being developed in the program either hardware or software
- The size of the program
- The organization of the program and R&D projects (in Sub-Case 1 the development task was not an R&D project like in the other two Sub-Cases, and therefore the task in Sub-Case 1 was comparable to the R&D projects in Sub-Cases 2 and 3)

Here it must be pointed out that due to the confidentiality issues towards the Case Company (e.g., the publicity requirements, traceability of the R&D programs as well as the suppliers) it was decided that general summaries and the comparison of the Sub-Cases as expressed in Appendices 6–9 would provide enough information for understanding the case context. Also, since the appendices show the relative positions of the three programs, it was found unnecessary to disclose exact details on the programs or projects and sub-projects.

5.2 Motivations and risks behind interaction

The fundamental question of the study concerns the motivations and risks to share confidential, company-specific R&D information with R&D suppliers. In the interview framework this issue was clarified in Category 5 questions shown in Appendix 2. The sharing of information is highly interrelated with collaboration in

general, and therefore motives for collaboration were asked as well (Category 4 questions).

Motivations

The motivation behind information sharing is twofold: it relates either to the lack of resources (which explains the need for collaboration in the first place), or to the nature of R&D tasks and thus the sharing of R&D information. The motivations behind R&D collaboration are several. First, the networking has come to stay: the focal company may not have enough resources or they require some specific capability to carry out the development tasks. Furthermore, the nature of collaboration is closely related to the maturity of the technology area[20]: If it is mature, the supplier base is already large, and the suppliers have more capabilities in this technology area. In this situation it is easier to find competent suppliers with which to collaborate. However, it must be pointed out that a lot of collaboration takes place even when the technology area is not yet mature.

The motivation of sharing information differs according to the type of information to be shared. Generally speaking, R&D collaboration requires information sharing on the strategic level, which normally takes place in supplier-specific steering groups. This type of information comprises business information and future trends, financial information, and even companies' strategies may be shared with the supplier (and vice versa). In the case of strategic information sharing the focal company wants to *motivate* the supplier in collaboration, and *develop and guide* the supplier's capabilities and resources in the right direction. In other words, the driver is to keep the suppliers informed about the customer requirements and the current business: the focal company may reveal the trend in the forthcoming technologies and in which areas the suppliers could develop their capability for their main partners.

[20] This refers especially to the technical maturity of the product family.

Program-specific information must also be shared: this type of information could comprise sales information about the product being developed (not numeric information but volume information) and other program management issues (schedules, customer requirements, etc). This type of information is also used to *motivate* employees in addition to *guiding* the work in R&D programs.

The third type of information is pure technical data (like requirement specifications, change requests, codes, and test plans). When sharing R&D information, the driver is clear: the complex nature of R&D tasks forces the focal company to share a lot of technical information on a need-to-know basis; otherwise the supplier is not capable of completing their task.

Risks

When talking about motives and drivers, the possible risks must also be evaluated. In the sharing of R&D information there is a risk that too much and too sensitive information flows to the suppliers. The interviews clearly showed that the sharing of information was not regarded risky in this sense: Only a couple of interviewees mentioned the risk factor in the first place. One interviewee was of the opinion that "*suppliers may not want to jeopardize their relationship with the focal company by behaving untrustworthy. Also, the NDAs and contracts already prohibit the sharing of confidential information to third parties.*" Additionally, many interviewees commented that "*the program employees do not even know such information that they could not tell to the supplier (of course, third party information and other sensitive information is not shared).*"

In addition to avoiding sharing too much information with suppliers, one form of risk is related to the possible information flows to the third party. To be more precise, a lot of information is shared electronically and the third party may capture confidential information, if the firewalls and technical restrictions are not adequate. Nevertheless, the Case Company was very careful about the protection of data and systems. Free communication, for instance, over cups of coffee about the company's problems is

also risky, because often also the supplier's employees may sit around the same table. That is, drawing the line between what to tell and what not to tell is sometimes difficult in such ad-hoc, informal situations.

In general, the sharing of information was not regarded a risk, although some interviewees admitted that data protection was not always used (especially in the beginning of the program). On one hand this was due to unclear guidelines concerning the *communication policy*, and on the other it was a practical challenge: the names of team members were not always known right away when the program began, and thus sending the *protection keys* was impossible. After beginning a program this was not a remarkable risk, since "*information sent in one email contained only parts of the whole documentation or critical information*" as one interviewee reminded.

All in all, when sharing information in R&D collaboration, attention must be paid to the sensitivity of information, and the extent to which such information is shared. This is challenging, since there are different types of steering groups and meetings in order to tackle R&D collaboration issues on the right level. For example, the top management steering group is far away from R&D, but it deals with business issues. The collaboration steering group is dedicated to each product area and takes care of the R&D programs. Furthermore, there are steering groups for a specific R&D program and a specific supplier. Project meetings deal with daily information sharing and problems faced in the development work. An architecture team may be established to understand the product in depth, to participate and guide the specifications and to transfer knowledge horizontally between the project teams. The interaction that takes place on different levels ensures that the supplier receives enough information. However, it may turn to a disadvantage: *is it somehow evaluated if the supplier gets too much information, when collecting it from different sources*? This issue was not handled in the interviews, though it should receive more attention.

In summary, the motives and risks in the sharing of information are closely related to the other features of the interaction process. For example, it was explained how the motivations to share information depend on the type of information. Moreover, information may be shared too openly in the informal conversations over cups of coffee, where supplier representatives may be present. This increases the risk of revealing too much company-specific information (e.g., problems of the Case Company are often discussed in the informal discussions). These relations will be elaborated in the following sections.

5.3 Information sharing

According to the original taxonomy presented by Möller & Wilson (1995), the interaction process can be divided into three parts: the exchange process, the adaption process, and the coordination process. It was concluded that for the usage of this thesis, it is more practical to concentrate only on one interaction process and handle the other processes as contextual factors. The adaption process will be described in the relationship-specific factors, and the coordination process as a determinant of the group level factor (the nature of the R&D program).

The information sharing process is divided into the exchange of resources and social resources exchange. These two processes are intertwined, although the sharing of resources receives the most attention in this study. Information sharing is analyzed through content, media, and style in the different episodes of the R&D collaboration. In the interview framework the questions about the nature of information sharing (Category 5) clarify this research issue.

5.3.1 Content

The type of information shared in the R&D phase fall into two main categories:

1) The strategic information (business information)
2) The operational information (technical R&D information and program/project information)

In the R&D collaboration context, operational information sharing takes place on the R&D program level, whereas the strategic information is shared in the supplier management steering groups and in other similar forums. Information is shared based on the actual need, avoiding everything-to-everyone. The strategic information consists of future trends and business strategies, the forthcoming programs where the supplier might have a role, product roadmaps, and financial information. In the upper management meetings information that *is not* shared is clear: third party information cannot be told, and for the most part the companies are careful when telling about the strategies and financial information, such as prices. When describing the motivations for information sharing earlier in this chapter, it was indicated that the way in which the focal company reveals their business strategy, future focus areas and technologies is very important to the supplier. The supplier can concentrate on these specific areas and increase their capability already before the forthcoming R&D programs and collaboration.

When moving to the operational level, namely, onto the R&D program and project levels, the content of information is very clear: practically all technical information is shared with the supplier. This includes information about specifications, codes, and test plans, among other things. During the interviews it became clear that information sharing culminates with the sharing and understanding of *specifications*.

One challenge in writing specifications is that it is difficult to forecast what the customer wants. Therefore, it should be checked *earlier* together with the customer, whether the requirements match the customer requirements. This requires close cooperation with the marketing unit and the R&D program management. Another challenge is that specifications require a deep understanding of the product being developed, and this type of capability is increased only when collaborating with the

specific focal company. Therefore, it is highly important that the *supplier* understands what they should do in the program, and the way in which the specifications are done and explained to the supplier becomes the key issue. In the studied programs the specifications were guided and done mainly in meetings or email exchange. The supplier's participation in the specifications phase depended on the project in question: the specifications were often done in the focal company, but in some projects the responsibility was given to the supplier, or specifications were done together. This organizational issue turned out to be critical in the success of the specification phase, and this calls for cooperation between the collaboration unit and the R&D program management.

A further direction for the R&D program management is to cooperate with the production unit. One important task is to make sure that the product being developed is easy to produce: for example, the number of components must be kept reasonable. Naturally this task is highlighted in the production of hardware. In order to communicate production-specific product targets to the R&D program, the representative of the production team often attends the R&D program meetings throughout the R&D process.

Another example of technical information shared in R&D collaboration is a *change request*. Implementing a change in the specification requires acceptance from the program management group, and the supplier has to give new estimates about the required resources and schedules. The change management process can be a complex, formal procedure consisting of third party involvement and official meeting minutes, or it can include only the new job description given to the supplier. In Sub-Case 3 the change requests were dealt with in an official process including reviews and a board meeting. When accepted, the change information was shared with all in the program by email or by arranging an information session. The official change management process was rather complex and it took a lot of time (3–4 months). In Sub-Case 2 the process was simpler and required the supplier's acceptance and evaluation of resources.

The *program and project plans* are other important pieces of information that must be shared. For example, sharing the general cost structure information with the program staff was mentioned to be relevant. The most confidential issues on the project level were in the program plans, which could include some resource information, prices, or third party information. The studied programs showed that there are different kinds of approaches and whether the program plan is sent or not sent to the supplier.

Several challenges relating to the content of information sharing were reported. One challenge in the interaction was that a lot of issues are taken for granted: it just does not come to mind to share every piece of information. Additionally, the following types of questions were asked: Which issues must be documented and which should not? Who needs this piece of information? How detailed a piece of information on product roadmaps can be shared with the suppliers? How do they get that information? These questions were asked especially in the beginning of the program, and they came up mainly in Sub-Cases 1 and 2. Asking these types of questions obviously tells us that the guidelines are not detailed enough. This issue is dealt with more thoroughly later in this chapter, when analyzing the contextual factors on the group level.

5.3.2 Media

The media of information shared in the R&D phase can roughly be divided into the following types as was suggested in the theoretical part: i) official face-to-face meetings (e.g., steering groups and project meetings with agenda), ii) unofficial face-to-face meetings (e.g., coffee and cigarette breaks, and other ad-hoc meetings), iii) telephone, iv) email, v) (common) databases, vi) net meetings and telephone conferencing, and vii) other (onsite coordinator). These media can be divided into synchronous and asynchronous media. The synchronous media expresses the rich media, where team members engage in interaction at the same time. Interaction by synchronous media consists of information sharing and social exchange, and could be

called communication. Communication takes place in face-to-face contacts (including onsite coordinators), telephone conversations, net meetings, and over cups of coffee. Asynchronous media – where the term *information sharing* is more appropriate – expresses a documented and therefore a formal way to share information, where team members engage in communication at different times. These both ways are important in R&D collaboration.

Synchronous information sharing

According to the interviews, the role of face-to-face contacts was highly emphasized in R&D collaboration. Face-to-face meetings were important for several reasons. First, the initial contact should be a face-to-face meeting so that the employees get to know each other and build trust (for example, the attitude towards another culture changes when meeting the other party). It also provides a rich medium, which is especially important in the beginning of the program, as usually there is a great need for all kinds of communication. In terms of cultural aspects face-to-face contacts are important, whereas the project issues as such do not definitely require that close collaboration. Also, in problem situations the face-to-face contacts are important. However, as one interviewee had experienced, "*face-to-face meetings may still experience cultural differences: for example problem issues are handled only after the meetings.*"

An alternative to face-to-face meetings are net meetings which decrease the amount of traveling. Net meetings proved to be an important way to share information especially in the multisite organization. However, these meetings often suffered from poor quality in voice and picture, which was emphasized when speaking in another language and especially when having a strong accent[21]. Additionally, delivering the meeting material was sometimes difficult because of technical restrictions (firewalls).

[21] This last point came up especially in the Sub-Case 2.

Telephone is a good medium when there is a need to get things clear right away, but the problem is that there is no later evidence of the conversation held on the phone. The interviewees also told that telephone could have been used more often instead of emails. The problem with the telephone is the barrier when speaking in another language: it is often easier to send email. Moreover, in Sub-Case 2 one reason for not calling was that the program's employees with the supplier did not have a telephone.

Onsite coordinators were an essential part in interaction in Sub-Case 2. They were located in the focal company's site partly in order to get information what is being done in the program. In fact, persons who were called onsite coordinators represented the supplier's team and acted in the interface between the two companies. In a way the onsite coordinator was the substitute of the supplier for the program manager. There were also other supplier personnel in the focal company's site, but they were normal project workers. In addition, to ensure information sharing with the supplier's team in their home country, it was possible that only the onsite coordinator had access to the tools required in the development work: it was not always possible to arrange these tools and access to them in the supplier's site. Furthermore, it was important that the supplier's representative also had an email account in the focal company's domain: it decreased the threshold to send email. Additionally it was easier to have interaction with onsite coordinators than persons who were working far away. The prerequisites for successful interaction and onsite coordinators includes following issues. One interviewee commented that "*the role of onsite coordinator is good, but there has to be more than one coordinator. Also, direct contacts must exist between the team members. Finally, the personality of the onsite coordinator is critical, since the success of the interaction largely depends on it.*"

Coffee break visibility is also important. An example is given in Sub-Case 1: The physical relocation of the supplier employees led to a decrease in conversations and informal discussions over cups of coffee. As a result, it was noticed that the specifications and other documents were no longer on a sufficient level for the

supplier, because the coffee break visibility was lost and these informal discussions had included a lot of information that was not documented.

Asynchronous information sharing

Asynchronous information sharing media are servers, databases, and emails. Common servers and email were used as a place for information storage before the product information database was launched. This common database was a general source of information where the location of documents and access rights were easy to define. It was also a medium for change management, and used for storing project information (meeting minutes, etc). In the beginning of the programs there were delays in the database, and it was not extranet-applicable. The problem in the product information database was that information was updated with a delay, which led to increased sharing of information by email or telephone. Another problem with the database was how the supplier could find the right document at the right time out of hundreds. It was the project meeting's task to inform about these new documents in the database.

Email is a very laborious way to communicate and it is used a lot especially with a smaller distribution list. In Sub-Case 3 this worked well, because the program and the projects were small. The disadvantage of emails is that a message might get lost and it takes a lot more time to discuss about problems in emails. Another interviewee pointed out that the problem of emails was that "*there were too many emails, too large distribution, and too much unprepared information*."

5.3.3 Style

The nature of the interaction style could be regarded by the following attributes: openness, frequency, and adequacy of information sharing.

Information sharing was described open and smooth in all three R&D programs, although there were some extra challenges related to the cultural differences in Sub-Case 2. An example of open information sharing is a situation where the project manager comes from the supplier organization. They may be present in the program management meetings just like the project managers from the focal company and get the same information as others though being a supplier's representative.

In some cases information sharing was more open than in others. The supplier's position and persons participating in the steering groups had an influence on the content and sensitivity of information shared in the steering group. One proof of open information sharing in the steering group concerned information which was not even shared with the companies' own personnel. One explanation for such a bold way to share information might have been the experience of the top managers and the ability to tell information so that it did not reveal too much to the partner. Moreover, having more face-to-face meetings may have had an influence on the openness of information sharing: the same information probably would have not been shared, for instance, in emails.

Information sharing took place rather frequently. This was an obvious finding in each program excluding two sub-projects (in Sub-Cases 2 and 3) where information sharing was rather limited and mostly took place in weekly meetings. The high frequency of information sharing was mostly a consequence of a complex R&D task, and in this sense, the high frequency can not be always considered as a positive issue.

Basically information sharing was regarded adequate due to the open and smooth process. However, the adequacy of information was difficult to evaluate, because the suppliers were not interviewed. In Sub-Case 2 it was admitted that more information could have been shared with the supplier. This was difficult partly because it was not known what the current situation with the supplier was; what kinds of problems and challenges they faced, among other things. One interviewee in Sub-Case 1 said that "*we got feedback of sharing too much uncontrolled change information*." Some

interviewees said that busy situations may cause inadequacy in information sharing. The adequacy of information sharing is closely related to the episodes of the program, which will be presented in the next section.

5.3.4 Episodes

The content, media and style of information sharing get specific characteristics according to the phase in the R&D program. It is useful to describe these characteristics in different episodes, because it will help to specify certain management means within the phases of the R&D program. It was proposed earlier that in the R&D context these episodes could be the beginning, the middle and the end of the program representing planning, production/development, and delivery.

Although excluding the pre-planning phase from this study, it must be reminded that important decisions concerning the program are made in this phase (e.g., the make-or-buy decision). After the R&D program has started, product features are clarified and the program and project plans are finished. By the end of the first episode the supplier has been selected and all parties involved should be aware of the development tasks, namely, the responsibilities and the working methods. However, even in the end of the first episode there were no clear plans what the supplier was expected to do. Therefore, *when the program began, information was not as structured as it was expected before the interviews* (see Section 5.1 and the discussion on the R&D process).

During the first episode the need for information is the biggest, and information sharing may not be adequate enough. This might be due to several reasons. First of all, the supplier's contact in the focal company (normally the project manager) may not have enough time to provide all the information at once to everybody. Secondly, there may be suspicions in the beginning of the collaboration, especially if the different parties have not met each other. Particularly the beginning of the R&D

program is characterized by the challenges in information systems. It takes a lot of time to get access rights defined, and this is not always taken into account when the R&D program begins. In Sub-Case 1 it was experienced that it was difficult to restrict the access rights of suppliers to relevant information: either the supplier saw nothing or they might have seen everything. This was improved later as a new common database was launched. Another challenging issue in the programs was having two programs going on at the same time: this may lead to a lack of support for the supplier when an old program is ending and a new one has already started.

Physical proximity and face-to-face meetings mean more in the beginning of the program, when team members get to know each other. Afterwards it is easier to communicate by other media. Cultural differences are an exception: for instance, in Sub-Case 2 face-to-face contacts were important throughout the program.

The main development work was done in the middle phase of the R&D program. Information was shared on a frequent basis, although it could vary from daily meetings to monthly meetings. At this phase information sharing received special attention when problems arose. The focal company had strongly pointed out that suppliers should inform them right away about any problematic issues.

The end of the R&D program focused on moving the developed product into production. Information shared in this phase consisted of final program and project reports. In this phase the pilot product was brought to the customer, and after the product had been accepted, larger production began. This could take place either at the focal company's own plant or at the supplier's site. In the end of the R&D program it became crucial to transfer the supplier's know-how back to the focal company (or the third party, who was responsible for production). However, this part of the interaction (information flows from the supplier to the buyer) is not examined in this study and in fact, this type of interaction refers mainly to the knowledge transfer instead of information sharing. Nevertheless, competence transfer should be

regarded as an important means in the management of information sharing, and this issue will be returned to later.

5.4 Context-related factors

The following sections will go through each context-related factor that appeared in the a priori framework. When going through these factors, their influence on information sharing will be clarified and explained.

First, the common characteristics will be analyzed. These refer to the industry and network level factors in the a priori framework. The common characteristics are the same in all three Sub-Cases, if not mentioned separately. The supplier characteristics and partly the buyer characteristics (i.e., the organizational level referring to the business unit and group level referring to the R&D program) are dependent on the specific Sub-Case, and if required, they are mentioned separately.

5.4.1 Environmental characteristics

The environmental factors relate to the R&D network and the current telecommunication business. In the interview framework (shown in Appendix 2) Category 2 questions concerning the current business environment clarified this issue. The main environmental context factor lies in the features of the telecommunication industry. The nature of the telecommunication business and its influence on information sharing was dealt mainly with those interviewees who represented the collaboration unit (instead of R&D program work). These interviewees had experience in collaboration in general. Moreover, since being managers, they had a helicopter view of the general telecommunication business. In general, the telecommunication industry is characterized by uncertain future prospects, high velocity, and changing customer requirements, and this trend is expected to continue

in the future. All these factors make information sharing more challenging because they force companies to share information more quickly and more frequently because the information content changes more often. In addition, the tight competition in the industry forces to pay attention to the efficiency of business activities, and thus it also touches the sharing of information.

One important characteristic of the environment deals with the maturity of the technology area. This issue has already been referred to in the context of motivation behind collaboration in Section 5.2. It was established that there is a relation between the size of the supplier base, the capabilities the suppliers have, and the maturity of the technology area. The role of technological maturity in information sharing requires more explanation. The studied R&D programs represented different technology areas: one of the programs was in an immature technology area when compared to the other two. In the current technology area of Sub-Case 3 the standardization was not very clear, but there were ”*sidetracks*”, as one interviewee put it. This means that when comparing current technology area to the former one, there are nowadays more forums which want to standardize their own issues. Developing an immature product technology means that *more* specification changes may take place, and this increases the need for information sharing.

Consequently, the R&D work becomes more unstable and changes occur more often. The unclear future prospects increase the collaboration challenge as well: “*since it is difficult to forecast the key technologies and products of the future, it is challenging to make decisions about on which areas to focus, which capabilities to develop, and which suppliers have the most capabilities to collaborate*”, as one interviewee pointed out. It was established earlier in terms of the content of information (especially in the specification phase) how important it is for the collaboration unit to participate with the R&D management in the issue of developing capabilities. Moreover, it is also difficult for the customers to specify their needs early enough, and customer uncertainty increases the possibility of changes (and information sharing) later in the program. This is related to the challenges in the specification

phase as well, and it was suggested that close cooperation is required between the marketing unit and the R&D management. The speed of the industry forces companies to make quick decisions and work under tight schedules. This obviously requires smooth interaction.

Since the focus in the study was to regard interaction between the focal company and one of the R&D suppliers in each R&D program, the discussion about the wider supplier network gained little attention. In fact, the role and characteristics of the network were explained within the maturity of the technology area. Furthermore, the challenges of information sharing clearly increase when other suppliers (e.g., documentation suppliers) are involved in the interaction loop, and the focal company has to operate between these two companies.

To sum up, two main characteristics rise from the environmental context (referring to the industry sector): the maturity of the technology area and the speed of the industry. The first one has indirect influence on information sharing also through the supplier base and suppliers' capabilities. This connection will be explained more in depth in the supplier characteristics.

→ *Summary on telecommunication business characteristics*[22]*: the maturity of the technology area (has an influence directly on the number of change requests, and indirectly on the capabilities of the supplier base) and speed of the industry (tight schedules between programs and within a program).*

5.4.2 Buyer characteristics

The buyer's (i.e., the focal company's) characteristics were identified when asking about the general business, R&D programs, and the nature of information sharing

[22] The main characteristics in each category are summarized and collected to the modified framework to be presented in Section 6.1.

(Categories 2, 3, and 5 in the interview framework shown in Appendix 2). They can be analyzed on different levels. In this study the focus is on organizational, departmental, and group level characteristics. These refer to the Business Area, business unit and R&D program in the case context. The organizational analysis focuses on the Business Area level instead of the whole focal company. The reason for this choice lies in the fact that the focal company is a very large company, and the two main Business Areas differ a lot from each other. In this sense already the Business Area level comparison brings about enough differences, and there is no need to consider the company as a whole. The individual level is given additional emphasis, however, without studying the socio-psychological behavior which would have led to a totally different research tradition.

When comparing the nature of R&D collaboration on the Business Area level, it can be said that the nature of business in the Business Area X is more predictable than in the other Business Areas of the focal company. This means that the R&D programs may begin and end in a slower pace. Naturally this decreases the challenges in the buyer–supplier interaction process, if there is more time to plan and realize the actions. Also, the attitude towards collaboration differs between the two Business Areas. In general, the tradition of collaboration in the Business Area of the study is towards larger entities in collaboration. Furthermore, one influential characteristic is the role of programs: in the Business Area X the programs are not as strong as in the other Business Area, and they could not make as much decisions, for instance, concerning the make-or-buy decision on the program level. As a consequence, the number of R&D suppliers can be smaller. This has an influence on information sharing because the amount of bureaucracy can be decreased.

→ *Summary on organizational (Business Area) level characteristics: the nature of business (relates to the environmental issues), history of collaboration, tradition of collaboration, and role of programs.*

When moving towards the business unit level, a comparison between the three case business units needs to be made. Since the R&D programs selected for this study represent the same Business Area, there are a lot of similar characteristics and practices within the business units. For example, general collaboration and R&D guidelines are common to each business unit, and they also refine the interaction process. An example of general guidelines is the requirements of each R&D phase. These should be distinguished from the guidelines the R&D programs share (for more, see the following section and group level characteristics).

Differences between the traditions of collaboration also appeared on the business unit level. For example, it was stated in the interviews that the business unit of Sub-Case 2 had fewer suppliers, and the selected suppliers had been given larger entities to be managed. This has an influence on information sharing, as was concluded above. Otherwise the comparison between business units is difficult: although the business units differ in their size and product selection, these issues are not regarded as meaningful as far as concerning information sharing in R&D collaboration. To be more precise, since the R&D program is the unit of analysis, the product being developed in the specific R&D program gains more attention. Because each business unit has a wide range of products, it is difficult to compare specific features (newness, architecture or complexity of the product) on the business unit level, although the product type originally explains the division of the business units in the Business Area X. Indeed, the product characteristics will be analyzed separately in Section 5.4.5.

→ *Summary on departmental (business unit) level characteristics: the nature of business (relates to the environmental issues and organizational level), history of collaboration, tradition of collaboration (also a characteristic on the organizational level), and uniformity of businesses and processes.*

Buyer characteristics differ the most on the *R&D program level*, which represents the group level in the original framework. The three programs selected for the empirical

research differ at least in the following characteristics: i) history of the product family, ii) size of the program, iii) schedule and length of the program, iv) organization of the program, v) coordination process, vi) amount of training, and vii) task characteristics (will be discussed in Section 5.3.6).

The history of the product family refers to the number of R&D programs in the same product family. If already several programs have been carried out, presumably the capabilities and experience of the personnel is higher, and the information sharing is smoother. This also means that there has been time to improve the processes and guidelines, which also makes the development work easier. Sub-Case 1 had the longest history, and this experience was clearly reflected in the interviews: information sharing was said to be smoother and processes were already streamlined.

The size of the program seems to have an influence on information sharing in two ways. First, a small program size makes general management easier (information reaches all the project members more easily, the management of access rights is easier, etc), and secondly, it increases the alternatives for information sharing media. Nevertheless, only few comments of the interviewees were related to the size of the program. In order to specify the size factor, the issue turns to manageable entities. For example, the size between the case programs differed a lot: Sub-Case 1 was almost ten times bigger than Sub-Case 3 according to the head count. The smaller the group or sub-group (i.e., an R&D project), the easier it is to manage. In large programs (like Sub-Case 1), there must be responsibilities on the lower levels, otherwise the follow-up and control do not work. One interviewee estimated that 15–20 employees are a manageable group size. The size of a program is also related to the choice of media in which to share information: an email message could be sent with a smaller distribution, whereas in a larger distribution the message should be saved for example in a common server.

The length of the program may relate to the complexity of challenging task characteristics, or the dependency of the program on other programs and/or products.

It could be assumed that information sharing is more challenging as a consequence of a longer program: more changes occur, and the possibility of employee turnover (and its influence on the decrease of the supplier's capability) is expected to be higher in a longer program. On the other hand, the means by which keeping the schedule of the program plan could have been achieved, for example, by extra resources and exceeding the cost budget. Therefore, these issues should be known before the program length can be regarded as a contextual factor in information sharing. For example, Sub-Case 1 was lengthened due to developing a totally new product instead of a couple of new features as it was expected in the original program plan. Additionally, the employees with the focal company were responsible for the newest developed parts, and the length of the program was not collaboration-related. Sub-Case 2 represents a situation where the program ended according to a planned schedule, but a lot of extra work was reported when compared to the budgeted figures. In Sub-Case 3 the supplier's part was finished in time: the program was lengthened, but it was not a consequence of the supplier involved in the program but the changes in the customer requirements. In sum, it is difficult to show the relation between information sharing and the original reason of the length of the program.

When speaking of R&D program organization, one characteristic rises above all others: the multisite organization[23]. That is, information sharing is the more challenging, the more sites there are involved in the program. In Sub-Case 1 the sites were located in several sites and cities in Finland and in one European country (the R&D supplier was in located in Finland). In Sub-Case 2 there were sites both in Finland and in Asia (the R&D supplier was Asian). Sub-Case 3 represented the easiest circumstances in a sense that the key R&D supplier and the focal company were located in the same city in Finland. The longer the distances between the sites, the greater the challenges of information sharing: it was mentioned in terms of the information sharing media that the role of face-to-face meetings is crucial in R&D

[23] In this study the multisite organization does not include all possible sites in the programs (e.g. those of the other suppliers) but focuses on the sites of the focal company and the selected R&D supplier.

collaboration, and it cannot be replaced by any other medium. This leads to the verification that organizing face-to-face meetings is also very important in the multisite organization. However, information sharing is definitely more challenging in the multisite organization, when the programs consist of several nationalities and cultures that communicate in a foreign language.

Another issue in the program organization concerns the organization on the buyer side and the supplier side: There should at least be equal positions on both sides (e.g., program manager or other responsible) to make interaction easier and that discussions take place on the right level. This was found especially important in Sub-Case 2.

In the a priori framework the coordination process was argued to fit better to the contextual factors influencing information sharing. The coordination process includes the guidelines, contracts, and conflict resolution mechanisms. Also, the level of focal company's control and intervention in the supplier's operations is discussed here. In the interview framework these issues are tackled with questions about the program and information sharing guidelines.

In the empirical research the guidelines were divided into the general collaboration guidelines and information sharing guidelines. Actually these are intertwined, since the collaboration guidelines should answer the questions of the supplier's visibility, the communication guidelines and such issues in addition to the general subcontracting process, contracts, etc. Many of the guidelines were common to all the three business units, but these were handled on the level of the R&D program, because the availability of the R&D program specific guidelines and the usage of guidelines characterized R&D programs instead of business units.

The general guideline in information sharing is to give the supplier as much information as they require to complete the task. In other words, "*information is shared on a need to know basis, avoiding the distribution of all information to everyone*," as one interviewee described. It was noticed in the interviews that the

guiding of information sharing was clear for the most part, because the lower level of program staff did not know such information they could not tell (the exception of third party information). These content-related guidelines were mentioned already when talking about the content of information. According to the interviewees, for the most part the employees were conscious about the restrictions concerning information sharing.

Generally speaking, the program plan as a guiding document received inconsistent opinions. Someone said that "*it is detailed to describe the different tasks and policies during the program*." Another one claimed that "*the program plan did not contain guidelines about the general documents and whether the supplier had read-access to them. There were no guidelines concerning specific issues arising especially in the beginning of the program*." This issue was highlighted in Sub-Case 2. In Sub-Case 3 one interviewee called for guidelines regulating "*what type of information can be shared by email*." These contradictory comments on the level of guidance show that there are differences between the R&D programs. Presumably earlier experiences and the history of the product family also affected the level of guidance, because less need for guidance was mentioned in Sub-Case 1, and most concerns came up in Sub-Case 2.

In addition to written guidelines, using of common sense had been found practical as well. In fact, often the employees were busy, and if there was no guideline available right away, common sense was used. Despite the clear guidelines there were sometimes questions on how to act (e.g., if there were a couple of lines in a document that could not be shared), and these issues had to be *consulted with the program manager or partner manager*.

When talking about the guidelines over the development work, some other issues were raised. According to one interviewee, "*guidelines provide information of what must be done, but the guidelines do not tell how to do it.*" When evaluating the importance of guidelines it should also be kept in mind that "*it is important to have*

guidelines and formal descriptions of what should be done, but another half of the success depends on the interaction between persons," as one interviewee reminded. Another complicated issue in terms of governance relates to the following comment: "*Guidelines are getting better through doing and learning*." This means that in the beginning of the collaboration detailed enough guidelines are difficult to make, and only time and gained experience will help. Consequently, managing sufficient guidance and preparing for it is a challenging task when starting collaboration.

Also, the forms of contract express a certain level of coordination or control, and therefore are linked with information sharing. There are typically three types of contracts, namely, time&material, fixed price, and risk&reward. One interviewee clarifies the differences between the forms of contract when saying "*If a development task is implemented by time&material (thus using hour-based subcontracting), it often provides the easiest way to get information. The explanation is that normally the employees may locate into the focal company's office, and they are handled for the most part as internal staff.*" Moreover, the interviewee contends that "*The fixed price contract defines the tasks (expected) of a supplier as well as the schedule and the price for the tasks in question… In the fixed price contract the task given to the R&D supplier is a more independent entity, meaning that there should not be as much need for information sharing as in the form of time&material... The risk&reward contract differs from the fixed price in such a way that the reward (as well as the risk) of the task is connected with the production volume*."

When comparing the fixed price contract and the risk&reward contract, the fixed price contract allows the focal company to intervene in the supplier's work, while according to the risk&reward model the supplier expects that they can work rather independently. However, in terms of information sharing the risk&reward is similar to fixed price.

Control and intervention in the supplier's work was identified a controversial issue among the interviewees. When collaborating and giving supplier independent product

entities to be completed, it could be expected that the amount of control is low. However, it was stated in several interviews that the complexity of the R&D task forced the focal company to control and intervene in the supplier's work frequently. This raises the following question: "What is the middle ground on the level of control?" Reviews done at the different phases of the R&D program represent another way to control and intervene in the supplier's doing. It is also a good place for the supplier to comment on the changes in resources and schedules.

When conflicts occur, issues escalate rapidly. Often face-to-face meetings were carried out to solve the problems, and occasionally the steering group level was involved in problem solving. These occasions were infrequent in the studied R&D programs.

Training own staff is a difficult issue to place on the right level in the company-specific factors. Basically training is part of a business unit's duties, and therefore falls to the departmental level. On the other hand, during the interviews the respondents referred to training required in the R&D program work. Additionally, the amount of training within the focal company is a factor that may have an impact on the experience and capability of the individuals. This close connection of training with different levels should be kept in mind, but here training is discussed in terms of the group level. Within the focal company this refers to the dilemma "whether the employees at the focal company have got enough training required in the running of the projects." It was concluded that the interviewees mostly called for training on collaboration- and program-related issues: How does the project management task change when R&D is subcontracted? More training was required especially on the program and project management levels, and although project management capabilities include a wide range of issues, it certainly increases the possibility to share information more smoothly. In particular, the program or project manager should be aware of the rules that relate to the information sharing guidelines, and this is emphasized especially in the collaboration.

→ *Summary on group level characteristics: the history of the product family, size of the program, organization of the program, availability and usage of guidelines, type of contract, level of control and intervention, and amount of training.*

The socio-psychological and behavioral factors influencing information sharing were intentionally left out of the study. However, a couple of individual characteristics were constantly raised in the interviews, and these are presented below. On the individual level the most important characteristics are the skills, capabilities and experience of the employees, their attitude, motivation, and interaction style. Of course the language skills also have a great impact on information sharing, but this issue will be highlighted in the supplier characteristics. The link between capabilities and the amount of information sharing is obvious: the more capable the employees are, the less need for information sharing there is. This issue was especially evident in Sub-Case 1, which was partly due to the long history of the programs in the product family, and everyone knew the processes and guidelines well.

There was sometimes also an attitude problem in the focal company. If the supplier was given a certain task, the attitude was not to interfere with their job, and the level of control was not enough. This was indicated especially in Sub-Case 2. Still, it was mentioned in several interviews that when doing these kinds of R&D tasks, it is not possible just to give the supplier their task and wait six months for it to get finished: there had to be some control, some intervention, reporting, or other type of follow-up despite the supplier having the full responsibility to do the task (see earlier discussion on control and intervention).

Another type of attitude problem typical of the Finns related to the willingness to help the supplier which was found out in Sub-Case 2. The problem was diminished when the supplier representative came to work in Finland and had face-to-face contacts with other program employees: now the Finns had more time and interest to help them. Currently the practice in Sub-Case 2 is job circulation, and for the whole

duration of the program a couple of supplier's employees work on site in Finland. When they return back to their own site, they can train other employees.

The motivation of the employees may be at different levels due to earlier arrangements taken place in the programs (this was seen especially in Sub-Case 1). Also, in the busy situations suppliers cannot be given as much attention as they would require. This is typical especially in the beginning of the program. The attitude of the employees may have a decreasing effect on information sharing if the interactants are not familiar with each other. Yet another important factor is the interaction style of an individual: some employees are more open and social than others; they may take a phone call while some others prefer emailing. This kind of interaction is clearly an issue of personality.

→ *Summary on individual level characteristics: the capabilities and experience of the employees, their attitude, motivation, and personality.*

5.4.3 Supplier characteristics

Supplier characteristics were determined by discussing the nature of collaboration and information sharing taking place with the selected supplier. These characteristics will be analyzed on different levels, as well, but because the suppliers were not interviewed, for example the visibility in supplier organization is rather poor. Therefore, the following sections go through the main characteristics which have been found influential in R&D collaboration from the focal company's viewpoint. The main issues covered on the supplier side are placed on the organizational level. An example is the coordinative issues of the focal company: it was quite easy to regard them as group level issues as they came up within the certain R&D program. However, in terms of the supplier's organization, it is impossible to specify whether the practices are common to the whole company or only to a certain business unit.

Nevertheless, if there was any experience of working on several projects with the same supplier, these factors fell in the departmental or group level category.

On the organizational level, attention is paid to the management style and company culture: collaboration and information sharing is easier, if these organizational features are similar to the focal company. The reputation of the company is also an important factor. It was experienced in the interviews that if the program's employees did not know the participating company, it was not a very good basis to begin collaboration. Normally this is the situation, if the companies are in different countries, there has not been much cooperation earlier, and the supplier is quite small. Obviously the culture of the supplier means a lot in information sharing. Again, cultural issues appear on the individual level in practice, but since the indications are the same on all levels, it is regarded more as an organizational characteristic. The different culture often means a different language, and this was regarded very challenging. Poor language skills were noticed, for instance, in the net meetings, when some people understood hardly anything. In addition, the supplier representatives might have spoken grammatically good English, but their accent was so strong that it was difficult for Finns to follow. This problem was increased in net meetings, when the quality of voice was poor because of technical reasons. Other cultural issues that came up in the interviews were hiding the problems and telling them in the last minute. Although these features describe the information flow from the supplier to the focal company, it has impacts also vice versa. Since the focal company does not know the real situation, it is difficult to share enough information. Additionally, the problems accumulate in the end of the program, and the schedules are exceeded or extra work must be done to stay in the original plan. A further cultural indicator is the employee turnover, which might be higher in certain cultures. When a new person comes to work in the project, it is clear that the capability is not right away on the required level. This is emphasized in complex R&D projects, where the tasks cannot be learned in a couple of weeks despite good basic knowledge and competence transfer. The cultural indications became very clear in Sub-Case 2.

As for the R&D collaboration, the most influential characteristic of the supplier is the capability which is required to complete the R&D task. The capabilities are always individual, but the way the company develops and takes care of the level of capability, is an organization level issue. There are different types of capabilities that matter in the R&D work. First, the capabilities can be general, which are easy to buy or gain in the market. For example, the capability in the R&D process (design or test) and the capability of the technology (programming languages, using of different tools) represent such capabilities. The most critical capability – and the most difficult one to gain or develop – is the product capability. This means knowledge about the product being developed, how compatible it is with older versions, etc. The product capability is improved only when collaborating with the focal company, and exactly this aspect makes the capabilities difficult to cope with. As a consequence, the impact of supplier capability on information sharing (and overall performance) is so significant that it is a strong motivation to develop close relationships. It would be resource-demanding to begin the capability development all over again with a new supplier.

The linkage between the amount of information sharing and the level of supplier's capability was indicated in many ways. Low or weak capability with the supplier requires a lot of contacts, "coaching" and thus information sharing from the focal company. The indicators of weak capability were seen, for example, in the programming code reviews. It became obvious that the supplier had not understood the certain technology area: programming capability was not enough, and additionally understanding of what should be done in the first place (i.e., understanding the specifications) was required. It is worth noticing that this cannot be regarded as a weakness only in the supplier characteristics: perhaps the program did not share the required information.

When speaking of capabilities on the program level, it must be kept in mind that working with the same company but within a different task does not increase the product capability: the tasks are rather different. The tasks differ a lot even within one

program. Experience and participation in earlier R&D programs in the same product family increases the supplier's process and tool capability. This experience helps especially in getting familiar with the focal company's processes and working practices.

Training is closely related to the capabilities of the R&D program members: by training the supplier (typically on product features) the focal company wants to ensure that they have enough capability in the development task. The challenge in the training of suppliers is that the situations change all the time, and there has to be continuous training. One form of training is competence transfer. It was discussed rather widely in the interviews, since a lot of competence transfer took place before programs began (especially in Sub-Cases 2 and 3). The competence transfer can be done in several ways, but the most successful way is so-called hands-on training, which means that the supplier's employee comes to work in the focal company's site and learns by doing. In Sub-Case 2 the most evident reason for partly unsuccessful competence transfer was due to the staff turnover taken place with the supplier after the competence transfer and before the R&D program.

One supplier characteristic relates to the physical location of the supplier's site. There is a clear linkage between the distance and the challenge of information sharing. Face-to-face meetings are more difficult to arrange, and there might be a time difference between the project sites. Despite the importance of physical proximity, it must be mentioned that the multisite organization is challenging even within one company or within the same culture. Yet, it is just more challenging, when it involves people from different companies and different cultures.

In addition to the factors mentioned above one could claim that the strategic importance of the supplier should be included here as well. In fact, the status of the supplier in the eyes of the focal company is definitely a significant factor, but since the selection criterion for all the three suppliers in the Sub-Cases was based on the

assumption of the key supplier position in the R&D program, the strategic importance of the supplier has already been taken as a given condition.

→ *Summary on organizational level characteristics: the reputation of the company, management style, organizational culture, language, capability of the supplier, experience in the same product area, amount of training and competence transfer, and physical location.*

A comparison between the supplier's business units – the departmental level – came up in Sub-Case 2, where one project team had experience in working with two different R&D project teams of the same company. The collaboration with one project team was successful, while there were a lot of challenges with the other team. These two teams had different working methods and ways to communicate with the Finnish project team: in the successful project many of the team members participated in the project meetings, while in the other one all information was shared through one person. In the first case the project manager could be sure of efficient information sharing with the supplier, while in the second case information got lost, and the project manager could not be sure whether all the team members with the supplier had gotten the required information. This example indicates not only the differences within the organizations (and their employees), but also differences between cultures (these two teams came from different cultures, though being in the same country). That is, despite different cultures, information sharing can be very successful. However, when evaluating the role of cultural differences in the sharing of information, it clearly came up that there were a lot more challenges in Sub-Case 2 than in the other Sub-Cases.

→ *Summary on departmental level characteristics: culture.*

When moving towards the *group level*, the organization of the R&D program or the project may have an influence on information sharing. Common experience was that the supplier should have had the same organization as the focal company: there

should be similar positions of program managers and project managers on both sides. This makes interaction easier and conversations take place on the right level. It was also experienced that the foreign culture appreciated a hierarchical group organization and consequently, information was shared only through the program manager. This creates delays in information sharing, because there are a lot of layers and bureaucracy in the interaction.

→ *Summary on group level characteristics: the organization of the program.*

Already several characteristics that clearly emerge on the individual level have been presented. Such issues are the language, the cultural issues, and to some extent the capabilities. However, the individual employee can to a great extent improve their performance by hard work and by having the right attitude. An example was given in Sub-Case 2 when a training session about the program's product was taking place: some of the workers studied the required product area in the evenings, and later they achieved the required level of capability more quickly.

→ *Summary on individual level characteristics: the language, culture, level of capability, and attitude.*

5.4.4 Relationship characteristics

So far the common characteristics, including industry and network level issues, have been presented and evaluated in terms of information sharing. Secondly, the company-specific characteristics have been distinguished and categorized under buyer (focal company) and supplier specific characteristics, leading to the discussion below on the impact of relationship-specific factors.

Category 4 questions in the interview framework (shown in Appendix 2) aimed to clarify the relationship characteristics. The two dominant factors influencing and

describing interaction behavior on the relationship level are the age of the relationship and the level of trust.

The age of the relationship has an influence on information sharing through the increased level of trust, experience in each other's processes and practices, and personal relationships. In the cases studied the age of relationships was similar, 5–7 years of collaboration at the time of interviews. However, in Sub-Case 1 the collaboration started all at once, while in Sub-Cases 2 and 3 the supplier had participated in earlier programs as well. None of the interviewees regarded the age of the relationship too short. The age of relationships is also related to the level of trust, which is presented below.

The level of trust indicates the smoothness of information sharing. Among the Sub-Cases studied the level of trust was sufficient: before the R&D program begins, a lot of negotiations have been accomplished, and trust is improved already before the beginning of the program. When the supplier was selected for the R&D program, it further strengthened the relationship, and it was developed in regular meetings on different levels (top management, program management, and project management). Also, an important position of the supplier in the program as such generates trust. The tight schedules force companies to build trust fast, since there is no time to wait and watch how the collaboration gets started. Having started the program, the most important ways to increase the level of trust are adequate capabilities, the fulfillment of the expected results, and constant communication especially in face-to-face meetings.

→ *The relationship characteristics: the length of the relationship and level of trust.*

5.4.5 Product characteristics

One of the selection criteria of the Sub-Cases was the complexity of the product. It was clear from the very beginning that in all of the R&D programs selected, the product being developed was complex. It was assumed that within the studied R&D programs, information sharing is extensive and partly so due to the product complexity. One measure of the (software product) complexity is, for example, the number of test cases: how many times it is necessary to test the product, and how many different features there are. This varied from 20 test cases to 500 cases, and they all had to be done in the same period of time. Another measure of the (hardware product) complexity could be the number of components or other elements required for the end-product. Following this logic, the products being developed in the Sub-Cases 1 and 2 are more complex than the product in the Sub-Case 3.

The product complexity may also result from a new technology. One case selection criterion concerned the newness of the product: the programs were selected so that each program represented a situation where the product being developed was old in a sense that it was familiar both with the focal company and the supplier (Sub-Case 1). In Sub-Case 2 the product was familiar to the focal company, but new to the supplier, and in Sub-Case 3 the product was new to both parties. As it was explained earlier (see Section 5.4.1), in an immature technology area more specification changes take place, which increases the amount of information sharing. However, the newness of the product may have one surprising feature which can have a positive influence on the product and program management. According to one interviewee, "*a new product could be followed up more carefully than an older product*." This argument makes the evaluation of the newness of the product even more difficult.

There was also another distinctive feature between the programs. In Sub-Cases 1 and 2 software products were developed, whereas in Sub-Case 3 the product being developed was a hardware product. Generally speaking the product type does not

clearly influence its complexity, but when comparing the three products in question, it can be stated that the product being developed in Sub-Case 3 proved to be the simplest one when it came to the architecture of the product. In other words, a hardware product is principally easier to specify and there are clear and manageable entities to be given to the suppliers. This product feature had an influence on information sharing so that it made the interfaces between the product entities (and between the participating companies) clearer.

During the interviews it became clear that comparison between the products was difficult. A product consists of different elements or parts, and there were a lot of differences among these elements. To conclude the discussion about the product characteristics, it can be mentioned that task characteristics provide a better way to analyze the impact on information sharing. Nevertheless, the following product characteristics will be regarded influential in information sharing, although their comparison in this study is difficult.

→ *The product characteristics: the complexity of the product, newness of the product, and architecture of the product.*

5.4.6 Task characteristics

Task characteristics refer to the involvement in the R&D project. In the software programs the task is typically programming or testing some feature(s) of the product, and in the hardware program designing a product feature. Category 4 questions in the interview framework (see Appendix 2) clarify this research issue.

There are several features, which should be taken into account when describing the task characteristics. Complexity of the task is clearly the main characteristic. In R&D collaboration a complex task is often in a new and immature technology area, it has a lot of human and product (thus architecture-based) interfaces, and it is not an

independent entity (a consequence of the number of interfaces). The maturity of the technology area has already been brought forward when discussing about the environmental context and the product characteristics.

A thin human interface means that there are only few levels in the information sharing process. At its simplest information sharing takes place between two engineers, who implement a common feature[24] and discuss together. It becomes more complex, if the interaction takes place through a program manager, project managers, or team leaders, and only after that reaches the "working level," namely, the engineer. The human interface is an organizational issue, and it was noticed that it is related to the culture of the supplier as well: in some cultures all information was desired to go through one person, who then shared information with their own organization.

An independent entity means that when a change occurs in one feature or part of the product, it does not have an influence on other parts. Thus, there are not so many interfaces to other features or parts of the product. This dramatically decreases the need for both information sharing and decision-making in the product interface. The challenge in the interface is also that it can adjust: it requires daily contacts with other interfaces, and an up-to-date status of the forthcoming changes.

One of the basic issues in characterizing the tasks is the core competence idea. That is, the tasks given to the suppliers must be general functions, which do not include any core competence. Otherwise it would harm the focal company's competitive advantage. However, this is a controversial issue. According to one interviewee, "*in my opinion, when doing a product, everything is core competence. Some of these competencies are ours and some other competencies are our partners*'. *When these competencies are streamlined, it is the key to success.*" This opinion emphasizes the idea of bringing suppliers strongly in the R&D process, and that all product areas are equally important.

[24] A common feature means that different parties develop the same feature of the product.

Another task characteristic that has an influence on information sharing is the status of the task when it is developed in-house. In other words, if some task is challenging already in-house, it is not an optimal target for collaboration. This feature relates to the project success in general, but it is evident that the more challenging the task, the more information sharing is required.

→ *Summary on task characteristics: the complexity, independency, number of interfaces, required capabilities, and in-house status before collaboration.*

5.5 Success factors and lessons learned in R&D collaboration

The second part of the empirical research focused on the means that could be used when managing information sharing in R&D collaboration. The interviewees suggested success factors which were important in the interaction process between the buyer and their R&D suppliers. Questions in Category 6 of the interview framework (see Appendix 2) were utilized to reveal lessons learned. The road to success begins with careful pre-planning and management of the program. Sub-Case 3 and one sub-project in Sub-Case 2 (Sub-Project 2B in the Appendix 8) revealed this kind of experience.

Although Sub-Case 2 had the most challenges among the studied programs, one of its R&D projects was an exception. The success of this project was based on several factors. First, the project started collaboration step by step, which gave the supplier time to increase their capabilities, learn new practices and processes, and gain experience. Due to this history the employees with the supplier and the focal company already knew each other, which made the interaction easier from the beginning. This success factor was clearly a matter of the collaboration management unit: they should make sure that the beginning of collaboration is as smooth as it can be.

A lot of success factors fall to the responsibility of the program/project management. For example, the project in Sub-Case 2 made sure that the supplier had enough technical support in the interface. This factor was found critical already in the previous programs. Moreover, when collaborating with the supplier that comes from a different culture, it turned out to be useful to take part in a cultural course[25]. Another success factor was that the project established a review system by which intervention in the supplier's operations and resources was easier. The project also arranged more face-to-face meetings to make sure that interaction was smooth. This was a conscious decision based on earlier experiences and it turned out to be a right effort. The last success factor relates to the management of the specifications phase: the supplier prepared own implementation specifications based on the focal company's requirement specifications. The supplier was also responsible for making work estimates and a proposal for the schedule and project plan. In this way it was confirmed that the supplier knew what they were expected to do.

Sub-Case 3 was regarded as a successful program as a whole. The main success factors in this Sub-Case were a competent and compact program team and smooth collaboration with other parties involved in the program. Thus, the selection of the right personnel is critical, and the importance of the right capabilities is highlighted again[26]. Risk management was given additional emphasis in Sub-Case 3: i) some key areas were handled as risks and their follow-up was stronger and efforts were put on tight collaboration, and ii) the supplier's tasks were carefully planned beforehand (i.e., clear responsibility areas with each party made the controllability and management of the program easier). Additionally, close, constant collaboration and social interaction were regarded as the key in collaboration: the program staff had to know each other well from the beginning (face-to-face meetings were required, as well as "management by walking"). Sub-Case 3 also carefully planned and

[25] Also other interviewees in Sub-Case 2 mentioned that cultural courses are useful.

[26] Note: the capability of the Case Company's employees was not exactly underestimated in the two other Sub-Cases. In Sub-Case 1 the problem of internal capability was related to the product ownership, and the fact that the program process model did not support this holistic view of the product.

implemented the specifications phase (i.e., in doing specifications together), and they had a streamlined process.

In Sub-Case 3 it also became evident that the focal company really focused on the pre-planning phase. In addition to the issues mentioned above, this included the development and guiding of the supplier's capability already before the program started. More specifically, the supplier was given information about the forthcoming technologies, and on which areas they could focus. These actions most probably helped in the supplier selection phase, and when evaluating whether the supplier had enough capability to do the development task. This was obviously a task that should have been done in the collaboration management unit.

In sum, these examples show that the success of a program consists of many smaller elements. Some of them have a direct influence also on information sharing (e.g., capabilities, pre-planning, and careful specification management) while some others have only indirect influence (careful supplier selection resulting in capable suppliers).

In addition to increasing the understanding of the success factors of the programs, the two examples show that despite challenging environments, the *management practices can tackle many challenges arising from the context*. For example, the Sub-Project 2B in Sub-Case 2 was considered to be a complex and large task, and working with the Asian supplier created yet other challenges. In Sub-Case 3 the starting point was the development of a new product, where the supplier did not have that much capability when compared to the other two suppliers of the study. Still, the R&D project in Sub-Case 2 and the R&D program (Sub-Case 3) were managed very well. On the other hand, some of the contextual factors could also be seen as success factors. It could be assumed that the hardware architecture, new product (which requires more careful follow-up), and small program size also contributed to the success of smooth collaboration and information sharing. The amount of work is smaller than, for instance, in interface software programs, which makes the coordination and information sharing easier.

These examples of successful R&D programs/projects and their success factors have helped to understand the connection between the management practices and contextual factors. In Section 6.3 the means to govern information sharing will be presented on a general level based on the cumulative understanding created in the empirical research.

6 RESEARCH SYNTHESIS

The main findings of the previous chapter will now be synthesized to create deeper analyses and gain theoretical insights. First, the elements of context-dependency identified earlier (Section 5.3) will be generated to the modified framework and compared in accordance with the existing theory. Section 6.1 will present this discussion. Then the analysis will be deepened, when taking into account the nature of information sharing (Section 6.2). After that the factors that have been highlighted as the most significant in context-dependency will be regarded from the viewpoint of governance (Section 6.3). Finally, drawing conclusions from the empirical data will be demonstrated (Section 6.4).

6.1 Elements of context-dependency

6.1.1 Modified framework of factors affecting information sharing

In the theoretical part it was suggested that an a priori framework (Figure 15 on page 109) should be constituted of factors on different levels in the company's environment (industry, network, and relationship factors), and within the company (organizational, departmental, group, and individual factors). Moreover, the task and product characteristics were handled separately in the a priori framework. Then a literature review was done in order to increase our understanding of the context-dependency specific to information sharing activity (Table 4 on page 119). Now it is time to analyze *which new factors arising in the R&D collaboration context have an impact on information sharing.*

It has been pointed out that the purpose of the contextual analysis has not been in specifying the importance of each factor, but in explaining their linkages and possible effects on information sharing. The following figure summarizes these factors.

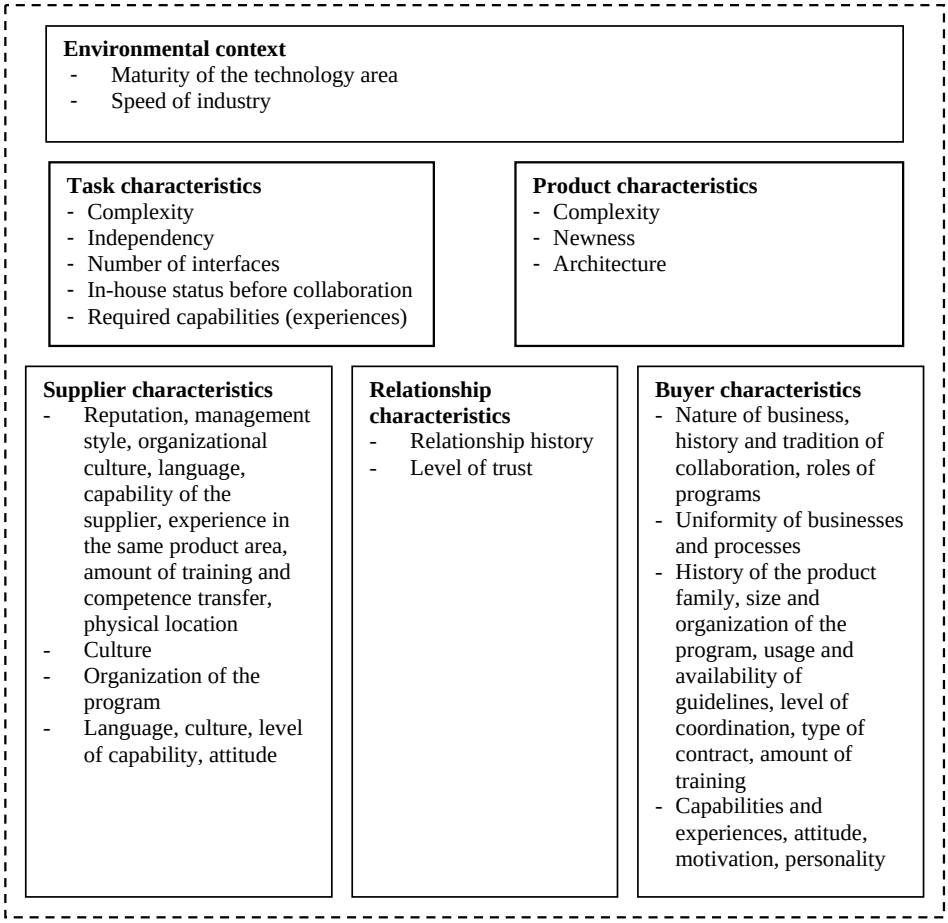

Figure 18. Modified framework on the context-dependency of information sharing in R&D collaboration

However, some factors presented in the figure above were more emphasized than others, and now these will be compared with the theoretical findings.

When comparing Table 4 on page 119 and Figure 18 above, a couple of notions can be made. First, on the industry level the existing studies consider the speed, competition and regulation as factors influencing information sharing (see e.g. Mohr 1996). The case study showed yet another factor that was regarded significant: the

maturity of the technology. Since the general standardization of the industry is not clear, the specifications adjust during the program. This is reflected both in the frequency of information sharing and in the accuracy of specifications. Furthermore, in a mature business the supplier base is larger. It means that it is easier to find capable suppliers, and this experience and capability decreases the need for information sharing. The immature technology and unclear future prospects came up in Sub-Case 3, where changes in specifications took place rather late in the program. This was due to the fact that even the customers were not able to specify early enough what they wanted, or their requirements changed during the development work. In other studied programs these change requests mainly came from other programs. The program in Sub-Case 3 managed well the changes, since they had put a lot of effort in defining responsibilities and streamlining processes. In the a priori framework Bensaou (1999) deals with the specifications under product characteristics, but as shown above, they are also closely related to the environmental context (maturity of the technology).

According to the literature review (see e.g. the studies by Bensaou 1999 and Johnsen et al. 1999), the most influential factors of information sharing were relationship-specific factors and the nature of the product. In the empirical part both of these factors where highlighted, and the results are in line with the theoretical assumptions.

The maturity (newness) of the product and the architecture of the product (leading to product complexity) are as such features that could be regarded as influential factors in information sharing. However, the role of product turned out to be an interesting one, since it was hard to compare the products in the first place. Therefore, it was suggested that instead of paying attention to the product characteristics, task characteristics should be regarded more important. In fact, there was some discussion about the product characteristics, but since a product consists of several elements or tasks, it is more useful to analyze these task-specific factors. This is verified by Dubois & Pedersen (2002) who argue against the use of product type as a starting point in network research. This is due to the fact that product is part of a complex

system where it is subject to interdependence in several dimensions: 1) any product is a result of numerous activities carried out by different firms, 2) the activities engage resources that are also activated in the production of other products, and 3) products are interconnected since they are parts of different technical contexts.

In fact, *the development tasks given to the supplier turned out to be the most critical one,* and interviewees suggested several characteristics to describe a successful task given to the supplier. In the literature review task characteristics were reported by Keller (1994) and Sakthivel (2005), and the empirical findings were partly in line with these studies. However, it can be claimed that task characteristics and their role in Supply Management were explained more thoroughly in the empirical research. Consequently, it could be expected that information sharing is easier, when the task possesses the following characteristics: i) it is a general feature (i.e., it is not a core competence of the focal company), ii) it is an independent entity (the changes in one entity do not have an influence on the other entities), iii) it has few interfaces (both human and product interfaces), iv) it belongs to a mature technology area, and v) it is not a problematic task already before collaboration when tackling it in-house. Due to the importance of task characteristics influencing information sharing, this issue is brought forward in the means of governance.

Additionally, some company-specific factors were highly emphasized. Primarily, the *capability of the supplier* proved to be critical which supports the theoretical findings as well (i.e., the perspective of dynamic capabilities). However, in this study the capabilities perspective goes a step further, when analyzing the types of capabilities required in the R&D work and what the means by which to manage the capability of the supplier are. First, three different types of *capabilities* required in R&D collaboration were introduced in the empirical research, and it was noticed that especially the most challenging one, *product capability, was improved along the supplier development and experience*. What is interesting here is the selection criteria of the programs, which were partly based on the level of capability the supplier had before the collaboration in the R&D program. In Sub-Case 1 the program employees

had the most experience and capabilities required for the development task: there had been many programs in the same product family[27]. In Sub-Case 2 there were differences in experience and capabilities between the projects (one project had begun collaboration a couple of years earlier than the others), but generally speaking, the supplier's capability had been increased step by step, and two programs preceded the studied program. In Sub-Case 3 the supplier had the least capabilities before the program started, because the product was technologically new. Still, as was proved in the empirical research, the capability of the supplier in Sub-Case 3 was actually very good: this was a result of the steering group activities, where the supplier had been told early on about the forthcoming program and what kinds of capabilities were expected.

Another means to increase the supplier's capability was *competence transfer* both between the focal company and the supplier, and within the supplier organization. However, far more important an issue is to prepare beforehand for the development of the supplier as was done in Sub-Case 3. This example does not eliminate the strong impact of capability on information sharing, but it emphasizes the significant role of the appropriate means of governance in information sharing (indirectly, i.e., through increased capabilities).

On the company level *the prior experience of the employees and the length of the R&D program* on the buyer side were regarded important. This became evident in the long program, where the processes and guidelines were regarded good enough, and everyone new from the beginning of the program what the tasks required were and how these tasks should be done. Other company-related factors that came up especially on the buyer side were the uniformity of businesses and processes, history of the product family, size and organization of the program, usage and availability of guidelines, level of coordination, type of contract, and amount of training. As an

[27] Also, the R&D supplier had increased their capability in earlier programs due to arrangements taken place between the companies.

example, *the long history of the product family* had an influence on information sharing through the streamlined processes and updated guidelines which were available: in terms of newer product development, the processes were still being developed and the working methods change. Accordingly, since the connection between the coordination process and information sharing was obvious, this should be considered as one of the importance means in governance (see Section 6.3 for more).

When comparing these results with the a priori framework, it can be seen that the empirical findings complement the existing research: for example, Albino et al. (1999) have noticed the importance of actor's prior experience as well. On the supplier side the reputation and management style were similar issues as found influential in the theory (see e.g. Mohr & Nevin 1990), but *the organization of the program as well as the supplier's prior experience* were other factors identified in the empirical research. Organizing the program (i.e., limiting the hierarchical structure and the role of "gatekeepers," as well as creating similar organizational structures in both companies) is naturally easy to tackle when compared to managing of supplier's prior experience.

In general, Sub-Case 2 is an example of how the different *culture* and long distance make the interaction with the supplier more challenging. It was identified in such comments as i) hiding of problems (makes information sharing more difficult, since it is not known what the exact problems are), ii) having very different facilities for communication (e.g. if the other party does not have telephones, it creates certain restrictions for information sharing), iii) emphasizing the role of face-to-face interaction (some issues are easier to be told face-to-face), iv) having more hierarchical organization structure (information was shared through one person, who acted as a gatekeeper), and v) having a different native language and strong accent (this was regarded challenging especially in the beginning of the program, and during the net meetings). However, when comparing to the theory (Daft & Lengel 1986), the cultural issues and language were regarded as the organizational level instead of (or

in addition to) being individual factors. The empirical research conducted in this study analyzes the impacts that the cultural differences have on information sharing, and how companies can respond to the challenges arising as a consequence of cultural differences.

Also, the *physical location* of the supplier was regarded highly emphasized in the empirical research: the nearer the supplier was located, the easier it was to arrange face-to-face meetings and the smoother the information sharing. The physical distance of the supplier is strongly related to the general organizational form that was typical in all three programs: all these were organized in many sites[28]. The interrelation between the *multisite organization* and information sharing challenges is obvious, although the interviewees pointed out that in-house R&D was challenging as well, when having a multisite organization. This is an important finding because in all three programs it came up that, for example, net meetings did not provide a good enough medium for information sharing. Instead, onsite coordinators and frequent face-to-face meetings were the keys to manage geographical fragmentation. These findings were supported the study by Sakthivel (2005). As she reported, it is obvious that knowledge-intensive tasks need co-presence, proximity and face-to-face interaction from the group members. Additionally, the co-location of the project team was identified as one of the success factors in new product development, for instance, by Ragatz et al. (1997).

Most of the contextual characteristics presented above hamper information sharing. In addition to these factors it must be pointed out that *trust* in information sharing is a prerequisite. The significance of trust in information sharing was found evident also in the literature review, where the role of trust was considered as a success factor both in the collaborative relationships in general, as well as in the success of new product development (Ragatz et al. 1997 and Parker 2000). The three suppliers involved in

[28] Note: only those organizations are mentioned which relate either to the supplier organization or the parts that are closely related to the R&D projects. That is, other suppliers are not included in this comparison of multisite organizations.

the R&D programs were in a similar position when speaking of the level of trust and the strategic importance of the supplier to the focal company. This position of the supplier in the eyes of the focal company clearly affected the smoothness of information sharing: despite the challenges reported, for example, in relation to different cultures, information sharing was regarded open, frequent and smooth in every Sub-Case. This verifies the common understanding that information sharing is extensive on all levels in close relationships (see e.g. Virolainen 1998; Ellram 1991). Also, the *history of the relationship* had a positive effect on the smoothness of interaction, although the interviewees emphasized the fact that the speed of the telecommunication business forces to establish (collaborative) relationships quickly. In this way it is easy to understand why the motives for sharing information were similar in all three programs. It also tells us that the general collaboration principles were similar within the three business units. To be more precise, both the strategic and operational drivers were equal in the supplier-specific steering groups as well as the R&D program work.

6.1.2 Summary

The following issues stood out when comparing the contextual factors with the factors included in the a priori framework. For the most part the contextual factors were in line with the findings of existing theories. This concerns especially the product characteristics and the nature of relationship. Instead, the task characteristics were given more prominence in the empirical research: the more challenging and complex the task, the more information sharing was required, and the more challenging the communication was.

When comparing with the literature review, the analysis of the R&D collaboration context went deeper into explaining the relation between the identified contextual factors. Examples of these types of results are the capability analysis of the supplier,

the analysis of company-specific factors which were analyzed on different levels, and the effects of cultural differences.

So far the discussion has been in the context-dependency of information sharing activity. On the other hand, when comparing the empirical research findings with the a priori model created for studying the context-dependency of general networking activities (see Figure 15 on page 109), a couple of issues come up. First, it turned out that the elements in the a priori framework were sufficient in order to analyze the context-dependency in the first place. As a matter of fact, for some parts the levels of analysis was almost too specified: for example categorizing the company-specific elements in four levels turned out to be challenging. Moreover, the task was even more challenging due to the low visibility to the suppliers' organizations. Secondly, when comparing the factors affecting general networking activities (i.e. Figure 15) to those identified in the empirical research (i.e. Table 4), it can be claimed that information sharing provides a good example of a networking activity. In other words, the contextual factors identified in the empirical research are similar to the factors in the a priori framework.

In the next section the impacts of these contextual factors will be explained more thoroughly in terms of different elements of information sharing.

6.2 Implications of contextual factors on the nature of information sharing

The previous section described some general impacts that the contextual factors had on information sharing. This analysis was mainly done on the level of decrease/increase in the amount of information sharing and general difficulty/ease of the interaction. Nevertheless, when combining the contextual factors with different elements of information sharing (content, media, and style), the implications on information sharing can be analyzed in depth. The following question was posed as part of the context-dependency of information sharing: *How the contextual factors*

influence the content, media, and style of information sharing? Before this analysis a summary of the nature of information sharing in R&D collaboration is provided.

6.2.1 Summary of the nature of information sharing

The following table provides an overview of the *main* features of information sharing. It has been divided into three episodes, because it was identified that these phases of the R&D program have an influence on the content, media, and style of information sharing.

Table 5. Summary of information sharing in the different episodes

Elements	Episode 1	Episode 2	Episode 3
Content	Project plans, program plan Specifications	Change requests, review meeting memos, program/project meeting memos	Final program and project reports incl. lessons learned, meeting memos, satisfaction surveys
Media	Face-to-face, email, database	Face-to-face, net meetings, database, email, phone	Database
Style	Frequent – a lot of information sharing Openness: least open during the process Adequacy: not always sufficient	Frequency depends on the number of problems Openness: more open Adequacy: enough	Frequency depends on the number of problems Openness: more open Adequacy: enough

It can be seen that the nature of information sharing varied depending on the episode of R&D collaboration. In the first episode the sharing of specifications and project plans was important, and there was a lot of interaction taking place between the companies. Still, the adequacy of information might have been poor. The openness of information was lower, because the collaboration parties did not know each other very well. In the second and third episodes the frequency of information sharing was normally decreased, unless there were problems. For example, detecting errors in the test phase could increase the frequency of meetings from one meeting in two weeks to two meetings in one week or even every day. Furthermore, the openness of information sharing increased as the program proceeded. It is worth pointing out that

strategic information is not mentioned in the table. This does not mean that such information would not be shared during the three episodes, but it is more valuable *before* the program begins. That is, the sharing of operational information is more emphasized during the program.

In terms of the information sharing media it can be concluded that in the early phase of the program all kinds of media were used, while later in the program less face-to-face contacts were required, and common databases and emails were the main media. The media related to the content in a way that project information was easier to send by email, while specifications required a face-to-face contact, if it was possible to arrange. Otherwise a common database was the official place used for the storage of R&D and project documents. Strategic information was mostly shared in face-to-face meetings.

To sum up, the analysis of the nature of information sharing led to the following findings:

- The nature of information sharing varied especially when moving from one episode to another: emphasis should be given to the early phase of the program.
- The face-to-face meetings were highly emphasized as an information sharing medium.

Next, the content, media, and style of information sharing will be scrutinized, while taking the impacts of contextual factors into account.

6.2.2 Relation between the contextual factors and the nature of information sharing

Content

The content of information is divided into two main categories: 1) Operational information consisting of R&D information (technical product information such as specifications) and R&D project information (general information relating to the project management), and 2) strategic information (business information). R&D information is so complex in its nature that the focal company is actually forced to share all this information despite the circumstances. However, the maturity of the technology, the early phase of the program, the culture of the supplier and the task complexity, as examples, make this type of information more challenging to share. On the other hand, high level of trust and long collaboration make information sharing smoother.

The nature and role of strategic information (i.e., information shared in the steering groups) is different. In other words, the sharing of strategic information is aimed to guide and develop the supplier's capabilities and actions into desired direction. It is also used to motivate the employees. When comparing R&D information with business information, the focal company becomes more careful: sharing of business information is restricted, meaning that information concerning, for instance, prices and other financial information as well as the capacity information of other suppliers is not shared. Still, it can be claimed that strategic business information is often shared openly. This was identified when interviewees said that such business information which was not even shared with the focal company's own staff was shared in the steering groups. It was also said that the experience and courage of the top managers as well as the information sharing medium (steering group meetings are always face-to-face meetings) increased the openness in information sharing. The assumption of sharing strategic information in face-to-face contacts (a finding in the study by Larson & Kulchitsky (2000) was verified in the empirical research).

However, this study highlighted also sharing of specification information in face-to-face contacts.

All in all the specification phase turned out to be the critical factor influencing the success of information sharing. It is very important that the supplier understands the specifications, namely, what they should do in the program. There were several ways to ensure the sharing of specification information: specifications could be done together, or the focal company could send a key specialist to share specification information in a face-to-face contact, or the supplier could take the responsibility of doing specifications.

Media

Face-to-face contacts were highlighted as an information sharing medium in R&D collaboration. Email is a medium that was used a lot, but it was also claimed for being a slow way to discuss and solve problems. Too many emails were sent, which increased the possibility to lose important information. Net meetings turned out to be an important medium in the multisite organization, but the medium suffered from poor quality. Some interviewees claimed that *technical issues* (access right management, functionality of the extranet solution) made information sharing challenging, and the supplier did not have the latest information available right away. Typically, the supplier did not have access rights, the employees could not use the common database, and access right management was not controlled.

One problem with the media was that they were not ready when the program began. The changes in information systems created big challenges as well: for instance, audit revealed problems in the common database when some of the earlier program's information was not available. Due to these reasons it is important to pay attention to the careful pre-planning of the program. However, it must be stressed that many of the media-related issues presented here were identified challenging already in-house. Therefore, they are not particularly collaboration-related, although the challenges may be emphasized, for example, due to using a foreign language and strong accent.

The choice of medium is mostly dependent on the circumstances on the R&D program level: the small size of the program easier leads to using phone and email, while larger programs have to share information mainly through databases. The multisite organization increases the usage of net meetings, although the importance of face-to-face contacts cannot be underestimated even in the multisite organization. Moreover, the culture of the supplier has an influence on the information sharing medium as well: face-to-face contacts may be emphasized in some cultures, such as the Asian culture (Sub-Case 2). Also, complex R&D tasks drive to arrange more face-to-face meetings.

Style

It was suggested in the theoretical part (see the summary in Section 3.1.3) that the main style characteristics are the *openness, frequency and adequacy* of information sharing. Generally speaking, information sharing was regarded smooth and open. The adequacy of information was good in general, since the nature of complex R&D work forced to share a lot of technical information (i.e., on a need-to-know basis). Still, there could have been even more frequent and adequate information sharing in the beginning. On the strategic level and in the program management meetings some nice-to-know information was shared as well. *The need for information sharing was most emphasized in the first episode*, when all types of information by all kinds of media were shared.

Several contextual factors seem to have an impact on the style of information sharing. On the industry level the maturity of the technology is reflected in the style of interaction in a way that unclear standardization and future prospects increase the amount of specifications change, which leads to a higher frequency. When the technology gets more mature, the frequency decreases. Similarly, information is adequate enough when the technology is mature. The supplier's capability has similar effects: the increase in capability will lead to a decrease in frequency, but it confirms that the adequacy of information is good (i.e., capable suppliers do not need as much information).

The multisite organization clearly affects the interaction style: information is not as open or adequate as it is shared more often by email, phone, or net meeting, and it increases the need for more frequent information sharing.

The influence of culture on the information sharing style is straightforward. In similar cultures the openness, frequency and adequacy of information sharing are higher than in different cultures. A different language creates clear problems in the smoothness of information sharing. The impact is similar as in the case of culture. The impact of trust is equally obvious: high level of trust facilitates open and frequent information sharing which increases the adequacy of information. The age of the relationship has a corresponding impact as the cultural factors and the level of trust: information is smooth by all measures in an older relationship[29]. This fact leads to a suggestion that it is beneficial for the focal company to invest in close, long-term relationships – a finding that has been noticed in the supply management literature (see e.g. Virolainen 1998).

Task characteristics seem to have the following effects on the style: when the task is simpler, there is no need for frequent information sharing, and information adequacy is good.

When guidelines are adequate enough, the frequency of information sharing presumably decreases, whereas the adequacy of information increases. The contract type has an exact opposite impact on information sharing: the contract form *time& material* guarantees smooth information sharing, since it was established that the supplier's employees were often situated in the focal company's site and they received almost the same information as the staff in the focal company. Instead, the often used contract form *fixed price* gives the supplier more space to work independently, but it also decreases the amount of information to be shared.

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[29] It is worth noticing that the speed of the industry forces to build up fast trust and tie close relationships in a short time frame.

6.2.3 Summary

All in all, when taking a closer look at the factors that have an impact either on the content of information, medium of information sharing or the interaction style, it can be seen that a couple of factors are common: *the phase of the program, the culture of the supplier and the complexity of the tasks*. Additionally, the *capability perspective and the maturity of the technology area are important factors in the content and style*, but it does not have a clear link with the choice of the medium. Vice versa, *the multisite organization has an impact on the choice of the medium and on style*, but not on the content of information.

When comparing these findings with the existing research, a couple of notions can be made. It was contended in the theoretical part (Zahay et al. 2004) that information shared in the NPD process may constitute of eight types of information. However, in this study the focus was given only on two rough categories, namely, strategic and operative information. Additionally, the operative information was limited to the technical and project information, and other types of information were excluded (e.g. customer information).

All in all it can be stated that the ways in which the Case Company shares strategic information is in line with the findings of the previous studies. The empirical research verified the fact that strategic communication should be shared in face-to-face contact, while sharing of operational information could be shared in an asynchronous way (see the study by Larson & Kulchitsky 2000). However, this study revealed one significant area in the operational information, which also requires a face-to-face contact: sharing of technical R&D information, such as specifications. Furthermore, it was also found out that sharing of strategic information is very important already before the beginning of the R&D program, since sharing information about the future business and strategies is a good way to improve the supplier’s capability.

As the results by Leek et al. (2003) confirmed, the newer methods of communication (e.g. mobile phones and e-mail) are enhancing interaction between businesses, but they do not replace the more traditional methods: face-to-face meetings are still perceived as necessary. Also Larson & Kulchitsky (2000, 36) suggested that "purchasing professionals need to retain and sharpen their skills in using more traditional media, such as face-to-face communication." This statement was proved also in this study while emphasizing the role of face-to-face meetings in the R&D collaboration.

Because this study was implemented using case study research, it is dangerous to provide any general descriptions on the nature of information sharing in R&D collaboration. That is, evaluation of the nature of information sharing was based on a couple of attributes describing information sharing, and no metric was used in the evaluation of frequency, openness or adequacy of information sharing. However, the empirical part revealed some characteristics that describe the nature of information sharing *influenced by the contextual factors*. These findings would serve as a basis to study the facets of information sharing and their context-dependency in more detail in the future research.

6.3 Means of governance

The experiences of the interviewees, such as suggested lessons learned, and the description of the success factors in the R&D collaboration were drawn from when answering the following question: *Which means of governance are highlighted as a consequence of the context-dependency of information sharing?* This question was considered to have managerial implications because information sharing is regarded challenging. Actually it is challenging already in-house, but the collaboration context and the pace of R&D programs make it even more challenging, which increases the value of these means.

The list of means of governance is created by also taking into account the main challenges reported in the Sub-Cases. The means are divided into two types: 1) those means that are situated more on the collaboration level, and 2) those means that are in the program's responsibility. In this way the supply management perspective is easier to identify.

- Collaboration management
    - Managing content and amount of information
    - Decisions concerning the collaborated tasks
    - Selecting capable and experienced suppliers
    - Paying attention to the coordination process
- R&D program management
    - Paying attention to the beginning of the program
    - Preparing for cultural differences and physical distance
    - Focusing on competence transfer
    - Organizing the program

Each means is dealt with more precisely in the sections below.

6.3.1 Means of governance on the level of collaboration management

Four main means falling to the responsibility of collaboration management were identified. These were considered especially significant due to the strong relation to the contextual factors (task characteristics, supplier capability), and smoothness of the information sharing process (coordination issues). The first issue, namely, managing content and amount of information is not particularly a means stemming from the specific context, but from the general nature of R&D information (its sensitivity and risk combined with the necessity to share R&D information).

Managing content and amount of information

To this point, motivations and risks of sharing information have been analyzed. Also, when going through the nature of information sharing, it was found out that there is a need to concentrate on the content and amount of information that is shared with the suppliers.

In order to gain balance between sharing a lot of R&D information because of the *force* and having the expected benefits of information sharing, both the benefits and risks of information sharing should be evaluated. It is also important due to the cost effects: the intention is to avoid sharing too much information, which is directly related to the transactions costs.

The following type of classification could be useful when analyzing the risk class:

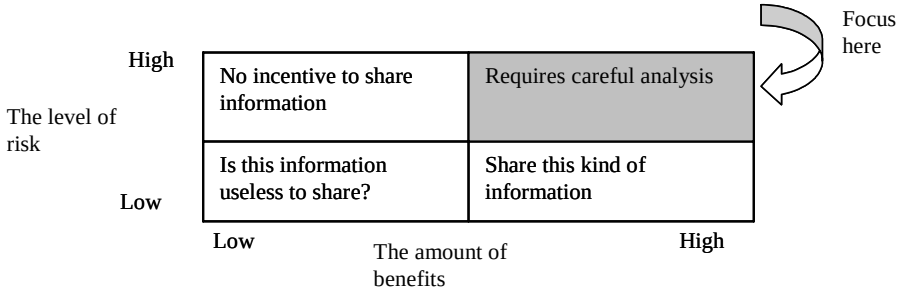

Figure 19. The risk/benefit analysis of information sharing

The risk aspect refers to revealing too much company-specific information to the supplier. The amount of benefits is evaluated from the focal company's perspective: are they able to benefit from sharing company-specific information with the supplier? As it was illustrated earlier, the motivations to share information differ mainly according to the type of information (operative/strategic) and the nature of the relationships.

In the lower left quadrant the sharing of information might be useless, if there are no benefits to be gained. However, some information may be useless for the focal company to share, but it could be regarded important on the supplier side. Sharing of general business information to motivate the supplier is an example of this kind of information. The risk in this quadrant is low as far as information does not contain too specific and detailed facts of the forthcoming business the focal company still wants to keep to themselves.

Typical R&D information (technical information such as specifications) often falls into the category “high benefit, low risk,” and this explains why this type of information should be shared. In the Case Company it was contended that technical information must be shared in order to make the supplier aware of the product they were about to develop. On the other hand, the risk to share too much information diminishes, when the focal company has clear rules for how much and what type of information can be shared and with whom.

The top left quadrant contains irrelevant information for the supplier. This type of information is for the most part financial information, revenues, margins, etc. The top right quadrant is the most difficult one when considering the challenge of information sharing. The benefits may be great, but they have to be evaluated against the risks that are high as well. This type of information is often shared by the upper management, and information is shared face-to-face, not using an electronic medium. The company’s strategic issues often fall into this category.

In summary, the categorization created above will help the focal company to analyze their risks that relate to information sharing. Furthermore, the evaluation of the gained benefits forces the focal company to understand the cost impacts of information sharing.

Decisions concerning the collaborated tasks

It was identified in the interviews that the tasks being developed by the R&D suppliers turned out to be the most critical factor that influences information sharing. Therefore, this issue is taken up in the means of governance. The decision concerning *make-or-buy* was often made on the upper management level, but in some cases the program could make this decision. It led to the fragmentation of collaborated tasks, and as a result, the decisions concerning the collaborated tasks were not always very well justified.

Task features appropriate for collaboration

The following issues should be taken into account when making decisions on the tasks that are appropriate for collaboration and have a positive influence on information sharing. The list is a synthesis of the views of the interviewees and the interpretation of the Author.

- If the collaborated task is an independent entity[30] collaboration is a success: if the task requires development in different projects or in both companies, the pressure for the speed and accuracy of information sharing is increased, and the success of subcontracting decreases.
- The collaborated task should have few technical interfaces and a thin human interface.
- If there exist internal problems, collaboration is not advisable (unless the supplier already has the required competence).
- If the supplier has a clear responsibility area, but is dependent on the focal company, there is a strong, technical connection: information sharing is increased and collaboration becomes more challenging.
- Collaboration is more successful when there are synergy benefits to be gained (should not be a "proprietary task": there is no added value if the supplier does not have enough competence).

[30] Although the target is towards larger entities to be collaborated, there is an inherent risk: the own capability concerning the product area in question could be diminished. It is the upper management's task to consider this issue.

- If there are own resources, persons, and capabilities within the company, there is no need to collaborate. There is no motivation, if the reasons for collaboration are not well justified.

Implementation of collaboration

Another issue relates to the implementation of the collaboration. Although it is a wide issue to deal with in this work, the key areas suggested by the interviewees were:

- There should be clear specifications in the beginning of the collaboration.
- Defining clear responsibilities for the program personnel is critical in collaboration.
- Collaboration requires more planning, project management, and supplier management capabilities and control. Again this requires more guidelines and training (especially project manager training with supplier-specific questions).

The above-mentioned issues speak for the importance of careful pre-planning of the program, and the role of the specification phase is highlighted again.

Selecting capable and experienced suppliers

Supplier selection was done properly in the studied programs, although in Sub-Case 3 the selection was done even more carefully than in other two Sub-Cases. This refers to the pre-planning of the program and work done in the supplier steering groups (development and guiding of the supplier). The supplier selection is an important factor determining the success in collaboration: the more capable and experienced the supplier, the less information sharing is required. However, it turned out to be difficult to keep the capability with the supplier especially in Sub-Case 2, since it was a cultural issue that the employee turnover was high. This is a difficult situation for the focal company to interfere in, but the key issue is that the supplier takes care of the competence transfer within the company, and the changes in the employees' competence should be informed right away.

Preparing and managing capable suppliers is complicated, because the supplier's capability seems to get better as time goes by and the supplier gains more experience. Therefore, collaboration should not be done on all at once basis, but step by step. Moreover, the maturity of the technology area is connected with the capability of the supplier: if the technology area is mature, the supplier base is larger and there are already more capable suppliers.

Paying attention to the coordination process

In general, the coordination process consists of guidelines, contracts, control and intervention, and the conflict resolution mechanisms. The most difficult issue was dealing with control and intervention versus giving the suppliers carte blanche which was indicated especially in Sub-Cases 1 and 2. This issue stood out in establishing the significance of the task being an independent entity in information sharing. One interviewee reminded that "*the focal company should not lose the visibility*," and thus the following question arises: what is the balance between control versus independence? It is good, if the focal company does not have to be involved in the supplier's tasks, but there is a risk that the focal company loses the capability (e.g., one development task is nowadays the supplier's expertise in Sub-Case 1). Furthermore, it was stated in several interviews that R&D tasks are so complex and challenging that the focal company has to be aware of the current status. On the other hand, the type of contract (often a fixed price) means decreasing the level of intervention and letting the supplier work more independently. There have to be good rules of the game and a similar understanding on both sides in the collaboration, otherwise it may turn into a conflict. More specifically, there is a danger that the supplier experiences that they cannot work independently enough, and the focal company suffers from poor visibility in the supplier's task implementation.

The guidelines were mostly adequate and detailed enough. Still, attention should have been paid to the beginning of the program, because, firstly, guidelines may not have been adequate when the program began. Secondly, some policies of general communication should have been checked: what information can be sent by email,

when it should be protected, and what extra issues must be taken into account when collaborating. Thirdly, most interviewees used common sense when determining what information could be shared with the supplier[31], and this may not have been a very good way of working, because common sense can mean different things depending on the person.

6.3.2 Means of governance on the level of R&D program management

Some of the means presented above also relate closely to the program level: for example, taking care of the adequacy of guidelines is the duty of the program level as well. However, the R&D program management level should consider especially the following practices. Again, this list has been generated based on the Author's interpretation of the most challenging areas in R&D collaboration and the issues arisen in the interviews.

- Paying attention to the beginning of the program
- Preparing for the cultural differences and physical distance
- Focusing on competence transfer
- Organizing the program

These issues were raised when evaluating the most challenging phases in information sharing (the beginning of the program). Cultural issues were highlighted in Sub-Case 2, and the physical distance was found challenging in all programs due to the multisite organization (however, in Sub-Case 3 the distance was actually manageable, since the companies were located in the same city). Competence transfer relates closely to the development of supplier capabilities and person turnover during the programs. Own staff should not be forgotten either, because person turnover also takes place in the focal company.

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[31] It must be kept in mind that all the interviewees were experienced in R&D collaboration, which makes using common sense more acceptable.

Paying attention to the beginning of the program

A careful, early planning of the program proved to be an important issue in managing the context-dependency of information sharing. This was experienced when introducing one successful R&D project in Sub-Case 2 (Sub-Project 2B), and one successful program (Sub-Case 3). They both paid a lot of attention, for example, to the careful pre-planning.

The level of information sharing varies according to the phase of the program: in the beginning the need for information is huge, and there is not enough time to tell everything right away. Therefore, it is important to nominate contact persons for the supplier to confirm smooth information sharing (project managers do not have enough time to share every bit of information) and define responsibilities of both sides. The key persons from the focal company should visit the supplier for a week or two and go through the requirements and specifications in detail with the supplier, and if possible, do the specifications together. This would have helped in understanding what the supplier really knows and avoiding mismatches. All in all, managing the specification phase turned out to be critical, and a lot of attention should be paid to it.

The focal company should make sure that previous programs do not tie up employees and their capabilities with regard to forthcoming programs: the lack of time and resources is an obvious consequence, if employees have to take part in two programs. Also, the technical facilities should be prepared early enough: it was mentioned that the access right management took time, and the media (especially common databases) to share information from the beginning was not always available.

Preparing for the cultural differences and physical distance

The issue of culture and long distance created challenges in Sub-Case 2. However, as pointed out by one interviewee, "*it is often an excuse to claim the different culture or long distance of the supplier*." Experience has shown that if becoming aware of the possible cultural challenges, they are easier to confront and prepare for. For example,

taking part in a cultural course was regarded important. Face-to-face interaction might be highly appreciated in another culture, and therefore frequent face-to-face meetings should be arranged. Especially important this is in the early phase of the program to let employees know each other. Net meetings and onsite coordinators were also keys to overcome challenges in interacting with people coming from another culture. Sometimes there are situations, where the focal company is unarmed. Learning to listen and understand a strong accent merely requires time, and in general the collaboration becomes smoother only gradually when the employees learn to know each other.

Focusing on competence transfer

The supplier capability was identified as a key issue in information sharing. Some of the means were proposed to belong to the tasks of the collaboration unit, but also the program should confirm that competence transfer has taken place early enough, and it is carried out effectively. Job circulation and hands-on training are ways to improve competence transfer: it cannot be implemented successfully without face-to-face contact, as was experienced in Sub-Case 1. The success of competence transfer depends on the individuals in the area that is being transferred, and on the attitude of the individuals transferring the competence. One means in the governance is nominating contact persons who really are responsible for sharing information.

Organizing a program

Program organization must support the product competence during the program. In Sub-Case 2 the program suffered from program level interaction. That is, the interaction took place on the project level, and the program manager was not aware of what was going on in the program. The solution was to create similar organizations in both companies, which made sure that the discussions took place on the right level. Additionally, due to the cultural reasons, the supplier in Sub-Case 2 preferred hierarchical organization, but it was noticed in the focal company that this would impede smooth information sharing (one person acted as a gatekeeper). It is not always in the hands of the focal company to interfere in the organization on the

supplier side, but at least the focal company can arrange the program organization to support smooth information sharing.

6.3.3 Summary

In sum, the means of governance were divided into two groups based on the unit that was thought to have the responsibility in the coordination. Still, it is worth mentioning that to implement these means successfully, the two units should work together. It is one means of governance as such, and actually the constant intercommunication with the marketing and production units should not be forgotten. This issue was raised also in Section 3.1.4: Parker (2000) suggested that there should exist consultation between the technical and marketing personnel.

The nature of R&D information, its complexity and sensitivity forces the company to evaluate carefully the risks and benefits to be gained in the sharing of information. The risk of losing company-specific information is inherent, although collaboration with long-term suppliers diminishes the risk that the supplier would abuse the information. These findings support the earlier suggestions of the risks in information sharing (Section 3.1.4: Mohr 1996). He pointed out the trade-off between widely disseminated information and protection of information, which should be considered carefully in R&D collaboration. Moreover, Lamming et al. (2000, 681) refer to the Barney's framework (1991), and assume that as firms rely on and protect their unique resources, they may be expected to exercise caution in sharing them with other parties. However, Lamming et al. also point out the fact that little research to date (2000) has examined this particular problem.

A closer look at the means of governance demonstrates that the key challenges derived from the business environment relate to the capability of the suppliers (selecting capable and experienced suppliers and focusing on competence transfer) as well as other characteristics of the supplier (preparing for cultural differences and

physical distance). In the theoretical part the evaluation of the supplier's capability was also pointed out by Svahn (2004). In this thesis the R&D programs and R&D suppliers within them were partly chosen based on the different levels of the capability of the suppliers. It was assumed that in the case where the supplier has already the capability to complete the task, there is less need for information sharing, while the information sharing is more extensive, when the supplier does not have a full capability to complete the task. This is in line with the theory of dynamic capabilities (see e.g. Teece et al. 1997). Also the study by Harland et al. (2001) suggests that supply networks characterized by dynamic environment and high degree of focal firm's supply network influence, the partner selection plays a critical role.

The importance of the coordination process refers to the discussion of determining the appropriate level of control and intervention: due to the complexity of the R&D tasks the focal company has to interfere in the supplier's doing, but on the other hand, they should also trust the supplier and believe in their capabilities. This issue remained unsolved in the empirical research. The rest of the practices relate to the operative arrangements taken place in the R&D management unit: paying attention to the early planning and beginning of the program as well as organizing the program so that it guarantees smooth information sharing.

When returning to the success factors identified in the theoretical part (Section 3.1.5, Table 3), it can be concluded that the Case Company has already put a lot of efforts in developing a smooth R&D strategy (e.g. direct, inter-company communication, NDA practices, strong collaboration). Also a lot of practices affecting the success of collaboration (e.g. trust, teamwork, longevity of relationships, openness) have been already implemented in the Case Company. Instead, the elements of information sharing strategy would require checking: One way to proceed in addition to the risk/benefit analysis is the checking of the communication guidelines in the Case Company, and they should be working from the very beginning in collaboration.

For the last issue, an interesting finding in the means of governance relates to the analysis of successful programs/projects. *It was concluded that despite the challenging circumstances where the R&D collaboration is taking place, the appropriate means of governance can eliminate the possible problems or challenges arisen from this context.* Of course some of the means are clearly affected by the circumstances (like the culture or capability of the supplier), but careful planning and coordination of the collaboration could tackle the challenging circumstances.

6.4 Drawing conclusions from the empirical data

So far the modified framework has been created (Figure 18) and the identified contextual factors have been compared with the factors found out in the literature review (Table 4). However, the identification of the factors affecting information sharing serves some notions that could have an influence on the interpretation of the research results. This discussion is important especially in terms of the quality of the research, more precisely because of the internal validity. According to Yin (2003, 36), the internal validity means that "...an investigator is trying to determine whether an event *x* led to event *y*." In this study it refers to the correlation between the identified contextual factors and the nature of information sharing. One way to tackle this challenge is to consider the outcomes of certain contextual factors and how they have influenced information sharing.

Outcome factors

In the a priori framework the outcome factors were given less attention, although they were regarded as one element in the interaction model presented by Möller & Wilson (1995). It was stated that the factors are analyzed if there are any clear relations between the outcomes and the sharing of information. The outcome factors could be seen as results that are produced by a smooth information sharing process.

In the interview framework (see Appendix 2) the outcome factors most often came up when the interviewees described the phases of the R&D project, or the challenges arisen in the interaction. That is, in the interview framework the questions in Categories 3 and 4 provided answers to the outcomes of interaction. However, the outcomes of interaction are difficult to evaluate, since many outcomes may be a result of several issues. For example, keeping to the planned schedule could have been achieved by competent and experienced employees, easy development task given to the supplier, and resources exceeded in addition to smooth information sharing. Therefore, only the most evident outcomes are presented here.

It has been mentioned already several times that the information the focal company shares in the upper management meetings, may guide the supplier to develop their capabilities into right direction (e.g., learning a new technology). Thus, *an outcome of sharing strategic information may be the increased capability of the supplier*.

Face-to-face meetings proved to be very influential in R&D collaboration. This was indicated in a couple of ways. First of all, there was *an attitude change among the project employees, when they had met each other*: when knowing each other, the collaboration was smoother, it was easier to take further contacts, and discuss about problems and challenges. Secondly, the face-to-face contact had an influence on the way the supplier (especially when coming from a different culture) *expresses their problems*: bad news are easier to tell face-to-face than, for example, in a net meeting.

Another important outcome relates to the status of the development task after the program is closed. It has already been explained, how certain tasks are so challenging that they should be developed or are developed again in-house. There were a couple of examples of these kinds of outcomes among the studied programs (and projects), but it was difficult to evaluate what was the result of challenging information sharing. It can only be speculated that since the task characteristics have a clear dependence on the nature of information sharing, *challenges in information sharing is one reason to move the R&D work back in-house*. This connection finds explanation in tasks

which have a number of human and technical interfaces, and which include such capability that the supplier does not yet have.

In addition to evaluating the outcome factors, yet some other challenges were faced when drawing conclusions from the empirical data. In order to improve the research quality, these challenges will be evaluated next.

Challenges in interpreting research findings

First, despite identifying the obvious connections between information sharing and contextual factors, the truth is more complicated. In fact, *the environmental characteristics are highly interlinked*: for example, they reflect the task and supplier characteristics (the maturity of the technology area has an influence on both levels). Also, *dealing with the organizational versus group and individual factors* was complicated: is language an individual characteristic or a group/organization characteristic? Language skills as such are very individual, but the strong accent was a characteristic of the whole supplier organization. Furthermore, the capability of the supplier appears on the individual level, but the way in which the supplier takes care of internal training and competence transfer, is rather an organizational than an individual issue.

Then, although recognizing the influential factors, the way they have an influence on information sharing is difficult to identify. For example, the size of the program was found to impact the choice of the medium, while the culture of the supplier may impact the way in which the supplier organizes the program team (hierarchical system), and only then makes information sharing more challenging. Therefore, the factors listed in the framework may have *direct or indirect* influence on information sharing.

Often the interviewees commented separately on such factors that were general challenges or features and therefore *not particularly collaboration-related* but also found challenging in-house. The multisite organization is an example of this kind of

characteristic. In spite of this fact the multisite organization is included in the modified framework, because it was regarded *more* challenging in the R&D collaboration.

Moreover, some of the contextual factors could also be *regarded as means* by which to govern information sharing. For example, the amount of training, or the level of control and intervention were such issues that also came up when discussing about the means that can be used in the management of information sharing. In this thesis it was proposed that these factors still fall in the contextual factors. The reason for this decision was that these means relate closely to the specific R&D program or more generally, to the departmental level, and are program-specific when comparing the contexts of the Sub-Cases.

Finally, the examples of different factors influencing information sharing are based on the experiences found in different Sub-Cases. However, the cross-case comparison has not been conducted consistently: instead, the focus has been given to the contextual factors inherent in the Sub-Cases. Occasionally there were references to the Sub-Cases, if some phenomenon was very different in other cases, or if the results were extremely similar. For this kind of analysis, Appendices 6–8 summarize the common and distinctive features of the Sub-Cases.

To conclude, recognition of the above-mentioned limitations and careful interpretation of the research results together with a well-reported analysis of the empirical findings are the keys to overcome the challenges in interpreting the data.

7 CONCLUSIONS OF THE STUDY

This final chapter of the dissertation will restate the research problem and discuss the major findings and contribution of the study. The methodology used in this study will be reviewed and suggestions for future research presented.

7.1 Summary of the research problem and structure of the study

The research purpose was to clarify the context-dependency of information sharing in R&D collaboration. Additional emphasis has been given to the governance of information sharing. The study was limited to the collaboration between the Case Company and their R&D suppliers in the Finnish telecommunication sector. In order to find out the context-dependency of information sharing and means of governance in this specific context, the following research questions were asked:

1 What is the context-dependency of information sharing in R&D collaboration?
2 Which means of governance are highlighted as a consequence of the context-dependency of information sharing?

Information sharing was regarded as a networking activity and considered more closely from the viewpoint of context-dependency. This approach provides arguments for regarding and analyzing the network as an activity environment, as has been emphasized e.g. by Harland et al. (2001) and Lamming et al. (2000). That is, it is important task for researchers in the field of supply chain management to try to classify supply networks into types that share important characteristics; thereby identifying practices of networking that are appropriate for managing in particular circumstance.

Consequently, the term *context-dependency* was offered as a means by which to respond to governing information sharing. Context-dependency was defined as something (here information sharing) which is determined by a set of interrelated conditions (here R&D collaboration). After recognizing the context-dependency of information sharing, it was possible to evaluate which means should be implemented in order to govern information sharing in the challenging circumstances. Although an understanding of the context-dependency of networking activity is a significant management item as such, the launching of means of governance aimed to provide yet more practical insights into the concept of context-dependency.

The study mainly follows the research stream of Supply Management, although information sharing has also been explained from the theoretical viewpoints (Resource-Based View, Dynamic Capabilities, and Transaction Cost Economics). It felt natural to start with the literature review on the nature of information sharing, and the main concepts, facets, benefits and challenges as well as the success factors were covered. Then, it was suggested that understanding the contextual analysis of factors affecting information sharing could tackle the challenges often related to collaboration and information sharing. These theoretical insights were examined in Chapter 3.

Chapter 4 focused on the concept of context-dependency: what it means, and how it links to the general analysis of networks and relationships. As a consequence, different taxonomies, elements and models describing the buyer–supplier interaction – or more specifically – the networking activities were turned into the a priori framework by which to study context-dependency. Sections 4.1–4.3 dealt with these issues. After that the literature review of the context-dependency of information sharing was completed with required levels and elements (Section 4.4).

Chapters 5 and 6 introduced the empirical research. First in Chapter 5 the context of the case study as well as the studied phenomena were described, and key findings were presented. In Chapter 6 a research synthesis was created which included a

modified framework of the context-dependency of information sharing, and the means of governance (Sections 6.1–6.3). In the end, drawing conclusions from the empirical data was demonstrated (Section 6.4).

The next section will go through the specific contribution of the study both from the theoretical and the empirical viewpoint.

7.2 Theoretical and empirical contribution

The review of the supply management literature revealed how large and fragmented an issue information sharing is. Previous studies on information sharing have mostly focused on the use of information systems (EDI, Internet) and the management of the logistics data (inventories, demand information, etc.). When regarding the communication between buyers and suppliers, there is a strong relation between the success of the alliance and the amount of communication. However, as was pointed out by Moberg et al. (2002, 767), "the literature provides little empirical support for the importance of information exchange or the characteristics and practices that will lead to increased exchange." *As a result of the theoretical part, the features and elements of the information sharing activity, as well as benefits and key concerns that are inherent in the collaboration were identified*. Having clarified the information sharing activity was of great help when later defining the context-dependency and generating the means of governance in information sharing.

Then, the concept context-dependency was explained and it was suggested how it can be studied in the field of Supply Management. The framework to study context-dependency of networking activities was generated by combining the different levels of analyses as introduced by Harland (1996), and the interaction models presented by Möller and Wilson (1995), and Olkkonen et al. (2000). These interaction models brought the networking activities, such as information sharing, to the framework. In addition to these, several other elements studied independently in the field of Supply

Management have been included in the framework (variables of the supply networks, as Lehtinen 2001 summarizes, the product characteristics introduced originally by Fisher 1997, and numerous studies of relationship-specific factors). *It was suggested that there is a need to combine different levels of network research, namely network, supply chain, dyadic relationship, and company. Moreover, the framework includes the task and product characteristics.*

This framework was utilized when structuring the research on the context-dependency of information sharing which has indeed been studied from different perspectives: The most obvious linkage has been recognized between the nature of information sharing and the type of relationship (see e.g. Bensaou 1999; Virolainen 1998). Another main factor, namely, the complexity of the product had also been clearly proven to increase the sharing of information, as was pointed out by Johnsen et al. 1999 and Lamming et al. 2000). These two factors were actually taken as given when selecting the case, and the three Sub-Cases concentrated on the information sharing in collaborative relationships between the Case Company and their R&D suppliers.

Later the empirical research findings complemented current understanding of context-dependency of information sharing. The question was *whether there were any new factors arising in the context that would have an impact on information sharing?* For the most part the contextual factors were in line with the findings of the existing theory. This concerns especially the product characteristics and the nature of the relationship. The task characteristics were emphasized the most in the empirical research, and additionally the maturity of the technology, especially in the specific product area, and the capabilities of the suppliers were regarded significant. Hence, *the empirical research contributed in identifying some other factors influencing information sharing.*

The analysis of the R&D collaboration context was deep in explaining the relation between the identified contextual factors. Consequently, when revealing the context-

dependency of information sharing, the following question was asked: *how do the contextual factors influence the content, media, and style of information sharing?* The main findings were as follows. First, the sharing of R&D information (as separate from project and strategic information) became challenging due to the maturity of the technology, the early phase of the program, the culture of the supplier and the task complexity. Secondly, the specification phase turned out to be a critical factor influencing the success of information sharing. Thirdly, face-to-face contacts were highlighted as an information sharing medium in R&D collaboration, and fourthly, the style of information sharing was mostly related to the episode of the R&D program, and information sharing was generally regarded smooth and open. Nevertheless, it must be reminded that also the nature of R&D collaboration forces to share information frequently and openly. Also the nature of collaborative relationships between the Case Company and the three R&D suppliers already included an assumption of extensive information sharing.

To sum up, especially the success of the specification phase was identified a critical factor in the information sharing, although emphasis should be given to the early phases of the program in general. It was also verified that the nature of R&D collaboration as such emphasizes the role of face-to-face contacts. As a result, the advances in technology and using the electronic communication media do not reduce the importance of face-to-face communication, which was regarded highly significant in R&D collaboration. This is an interesting finding, since there is a wide range of alternative ways to communicate. Indeed, the role of face-to-face meetings should not be underestimated. *After all, this study managed to clarify the nature of information sharing in R&D collaboration.*

Another main research question deals with the ways in which to govern information sharing under the challenging circumstances. Thus it was asked:

Which means of governance are highlighted as a consequence of the context-dependency of information sharing?

As stated earlier (Cox 1997; Lamming et al. 2000), the means of governance should be put in the right contexts to be effective. Some of the success factors in R&D collaboration were presented in the theoretical part (Section 3.2), but these practices were made concrete in the empirical research. After recognizing the most challenging issues stemming from the R&D collaboration context, the means of governing information sharing were identified in order to respond to the challenges of information sharing. The governance of information sharing was further divided into the collaboration level and R&D program level according to which party would be responsible for the issues arisen in the governance. The results are summarized below:

1) Means on the level of collaboration management
- Content and amount of information
- Decisions concerning the collaborated tasks
- Selecting capable and experienced suppliers
- Paying attention to the coordination process

2) Means on the level of R&D program management
- Paying attention to the beginning of the program
- Preparing for cultural differences and physical distance
- Focusing on competence transfer
- Organizing the program

Implementing the means shown above requires close cooperation between the collaboration and program management units. Additionally, the marketing and production units should work in cooperation with the R&D collaboration team.

The most important finding in terms of the means of governance is that *despite the challenging field of information sharing in the R&D collaboration, the challenges could be tackled by means of governance.*

In sum, this study has contributed in the field of Supply Management to six areas specific to information sharing:

1. It provided a detailed conceptualization of the term *information sharing* and revealed the nature of information sharing as a networking activity (Section 3.1)
2. It generated a framework for studying the context-dependency of networking activities (Section 4.3).
3. The framework was used to classify the elements of the context-dependency of information sharing (Section 4.4).
4. It identified new factors arising in the business context that could have an impact on information sharing in R&D collaboration (Section 6.1).
5. It provided deeper analyses of the relations between the circumstances of the business environment and the nature of information sharing (Section 6.2).
6. It highlighted some means of governance and evaluated them within the emphasized contextual factors (Section 6.3).

All in all, it can be stated that the main contribution of the study was to structure and analyze the levels and elements of networks and relationships within the interaction framework: this helped in understanding the general context-dependency of networking activities. When analyzing information sharing more in depth as a networking activity and its context-dependency, it became possible to recognize the most challenging areas stemming from the complex context where companies are operating, and to suggest some means of governance to respond to these challenges.

In addition to this theoretical contribution, this study has a *managerial contribution* as well. First, the concept *context-dependency* has been given emphasis in a way that managers would understand the importance of applying management practices in the right contexts. As a result of the modified framework of the context-dependency of information sharing, some significant factors stemming from the R&D collaboration context were highlighted. The influence of these factors was elaborated further, when showing the linkage between the contextual factors and the content, media, and style

of information sharing. Recognizing this context-dependency will then be of great help when trying to respond to the obvious challenges related to information sharing. Accordingly, the study has focused on the governance of information sharing and showed that there are many challenges that rise from the complex nature of information, from the collaboration context, and the culture and capabilities of individuals. Efficiency can be achieved when recognizing the circumstances that require certain ways to share information. Thus, this study is of importance especially to the companies that plan offshore activities or collaboration in general. It can be typical that concerns about arranging smooth information sharing and communication between the collaborating companies are not paid enough attention in the decision-making of other collaboration arrangements.

7.3 Review of the methodology and limitations of the study

Now the research methodology will be summarized, and the quality of the research evaluated. Also, the limitations of the study will be discussed.

This study has been conducted by using the qualitative research method. More specifically, the study is descriptive in its nature, and does not aim at statistical but analytical generalization. In other words, the objective of the study has been in understanding more profoundly the complex context of information sharing in R&D collaboration.

The empirical case in this research has been defined as a single case study, with three Sub-Cases and units of analysis (R&D programs). These three Sub-Cases have been analyzed in an embedded way, namely, within one company, in one of their Business Areas, and in three business units. Accordingly, this study is a single, *embedded* case study with multiple items. The study was also characterized by constant movement between theory and practice, where the earlier experiences and research findings

contributed to the following phase. Thus, the research has been conducted by using *abduction* as the research method.

The empirical evidence was collected using 19 semi-structured interviews as the main source of data. Additionally, some secondary information sources were used to gain more information about the telecommunication business and the Case Company in question. The role of the exploratory research (the project implemented in 2001-2003 at the Case Company) was also of significance in creating the Author's pre-understanding of the research problem as well as the research context. However, the project data was not used as such in this study.

7.3.1 Validity and reliability

When evaluating the research quality, the case study may be judged on the basis of validity and reliability. According to Yin (2003), three validity tests can be performed, namely, those of construct validity, internal validity, and external validity. In order to increase the *construct validity*, the following means have been applied: i) multiple sources of evidence have been used (interviews, secondary interview sources, additional documentation and pre-understanding as a consequence of the research project), ii) chain of evidence has been established (see the discussion below), and iii) the Case Company advisors and a couple of interviewees have reviewed and commented the case study report.

In order to evaluate the validity of the data, the following question must be answered: What is the role of the interviewees selected as the primary source of data? It was contended that all the interviewees had a long experience of working in the Case Company; thus, they could be assumed to have enough experience of the research context. In fact, since the interviewees either represented collaboration in general or had closer experience in R&D work, the Author could deepen her understanding from different perspectives. These views were supported by some other interviews (so-

called secondary information sources) which explained the general business of the telecommunication, the environment of the Business Area in question, as well as the R&D process in the focal company.

The interviews on the level of collaboration management increased the understanding of the supplier management issues and general telecommunication business. The interviews with the program management level turned out to be fruitful, since these interviewees had experience of different programs. They could also explain more profoundly the success factors behind R&D collaboration, and these interviewees also contributed to the elements of the coordination process. Sub-Case 2 was different from the other two programs because the R&D supplier came from a different culture. Therefore, two extra interviews were conducted to shed light on the understanding of these cultural differences. These two interviewees either were located in the target country or had spent there several weeks during the relationship history.

On the project management level the interviewees most often contributed to the daily work taking place between the focal company and the R&D supplier, and they were the best source for evaluating the nature of information sharing and the challenges of the collaboration in general.

The internal validity was mainly improved by pattern-matching tactics and explanation building (i.e. preparing interview coding, interview summaries, drawing of mind maps) and by conversations with the Case Company advisors. *The external validity* is the most difficult one to carry out in the single case study, but again the means suggested by Yin (2003) have been utilized. That is, the existing theories have had a strong role in explaining and elaborating the research results and thus the external validity of the study.

When evaluating the *generalization* of this study, a couple of issues have come up. First of all, the single case study does not aim at statistical generalization. Instead, as

verified for instance by Stake (1995, 7–8), the objective of the case study is to create a detailed view of the studied phenomenon through the cases, and the term particularization should be used instead of generalization. Yin (2003, 31–32) speaks about “analytic generalization,” where the developed theory is the level on which the generalization of the case study results will occur. To a certain extent the created concepts and models can explain other, similar phenomena occurring in similar contexts. At this point the following question arises: do the Sub-Cases selected for the study represent the R&D collaboration in the focal company? Furthermore, it can be asked even more widely: could the study be generalized in the telecommunication sector?

It was noticed during the interviews that there were both similarities (contextual factors, like industry or the coordination processes and guidelines in terms of collaboration) and differences between the Business Areas of the Case Company. That is, other Business Areas in the Case Company can also utilize the framework created for analyzing their business environment, although the emphasized contextual factors may be different. For example, since the Business Area X focuses on a typical project- based production, it is understandable that the task characteristics were highlighted in the framework. Nevertheless, also the other Business Area had a lot of project-based production in addition to mass production, and this way the impacts of task characteristics were the same. This also applies to other companies than just the Case Company.

The study was conducted in the telecommunication sector, and therefore the industry-specific factors, especially the maturity of the technology played a great role. The impacts of the industry could be the same in other young and fast developing industries to which the research results can be generalized. On the other hand, as was pointed out in the study by Lamming et al. (2000, 683), differences between types of supply networks could not be explained by differences in industrial context. That is, it is a natural feature of supply networks that they cut across industry boundaries. This view leads to the statement that instead of focusing too clearly on the generalization

from one industry to another, an attention should be paid to the features inherent in supply networks.

The reliability of the study was verified in Chapter 2.4, and the whole research process is summarized in Appendix 5. Some examples of the working methods in the analysis and data interpretation phases are described in Appendices 3 and 4, when explaining the classification principles of the data, and the ways in which the causalities have been found out. As it can be seen, the case study protocol has been applied and the case study database has been created in the data collection phase as was suggested by Yin (2003). Unfortunately, because of the confidentiality of the Case Company information, it was not possible to include all the documentation in this study.

7.3.2 Limitations of the study

This study follows mainly the supply management approach. However, since the empirical research has been conducted in the field of R&D, the better understanding of this research stream would have made this study more comprehensive.

One obvious limitation of this study deals with the chosen research perspective: while conducting the interviews only in the focal company, some relevant and significant information concerning the suppliers' perceptions remains unclear. Moreover, the confidentiality towards the Case Company has made it challenging to report all the relevant information that would have been required in order to understand the case context properly.

One great challenge was to make sure whether the indications and consequences identified in the R&D collaboration were due to information sharing, other management practices, or the differences in the contexts of the Sub-Cases. Also, limiting the research perspective to information *sharing* only was difficult, because so

much other interaction was involved in the collaboration. In other words, the conceptualization of the study has been challenging. Appendices 3 and 4 have been created in order to clarify the way in which the interrelations between different concepts have been understood and analyzed.

A couple of inherent limitations in the study were presented in the end of Chapter 6. That is, the following characteristics of the research problem and the empirical research have made this study challenging: i) the environmental characteristics are highly interlinked, leading to a difficulty to point out the exact correlation between the circumstance and information sharing, ii) dealing with the organizational versus group or individual factors was complicated, which made if difficult to place the factors on the right levels, iii) the factors listed in the framework may have direct or indirect influence on information sharing, which might over- or underestimate the significance of some factors, iv) some challenges or features were not particularly collaboration-related but they were also found challenging in-house, which might lead to wrong interpretations and highlighting the problems of collaboration instead of in-house R&D, and v) some of the contextual factors could also be regarded as means by which to govern information sharing, which would have emphasized the role of context-dependency.

Recognizing the above-mentioned limitations and carefully interpreting the research results together with a well-reported analysis of the empirical findings are the keys when continuing research in the field.

7.4 Aspects for further research

When evaluating future research areas, some relevant pathways came up. First, this study looked only at the focal company's side and opinion in R&D collaboration. Therefore, it would be interesting to include the *perceptions of the R&D suppliers* in the R&D program. Also, extending the focus to the other suppliers and customers of

the total R&D network as well would increase the understanding of information sharing in a *wider context*.

In addition to studying the empirical research context more broadly, the findings in the case context also provide interesting areas for future research. Firstly, for example the *evaluation of capability and competence transfer* would be interesting to examine more deeply than was possible in this research. Secondly, the important issue of the *collaboration success* and the *determination of collaborated tasks* are definitely interesting and valuable research issues especially for the companies, which nowadays also face a lot of challenges in collaboration. Thirdly, it would be interesting to *combine the effects of smooth information sharing and its management with the performance measures* (length of the R&D programs, number of specification changes, etc).

A different *research method* would also be an issue of future research. In this study the analytical generalization became evident when generating a framework in which context-dependency can be studied. Furthermore, our understanding of the nature of information sharing in R&D collaboration as such has grown. Moreover, since this study aimed at bringing forward certain factors affecting the context-dependency of information sharing, it investigated local causalities. A natural topic for further research would be *testing* the identified factors to a larger extent than in a case study by the interview method, thus reaching statistical generalization in the study.

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APPENDIX 1: LIST OF SECONDARY SOURCES OF INFORMATION

Introductory, informative meetings

Time	Persons participated	Organization and Position	Issues handled
12/2004	Thesis advisors	Business Area X/ Management	Introduction of dissertation
01/2005	Thesis advisors	Business Area X/ Management	Scope refining
01/2005	Thesis advisor	Business Area X/ Management	Terminology, company and case Business Area background
01/2005	Business Area X R&D process owner	Business Area X/ Management	Terminology, R&D collaboration
04/2005	Thesis advisors	Business Area X/ Management	Preliminary interview findings

Case Company -specific material

Company (Business Area X) R&D process descriptions

Program plan (Sub-Case 2)

Company intranet material, incl., e.g., communication guidelines, organization charts

APPENDIX 2: GENERIC INTERVIEW FRAMEWORK

1. Background information:

- Introduction to the thesis (introduced by the interviewer)
- Position, tasks, and working experience of the interviewee

2. General business environment

- What are the challenges and trends in the telecommunication business?
- What is the organization of the business unit like?

3. R&D program

- Organization and resources of the program
- Features of the product being developed
- Phases of the program
- Program practices: Guidelines and their implementation in practice

4. Collaboration with the R&D supplier

- Background to the collaboration (history of the relationship)
- Nature of the relationship in general
- Collaboration in the selected R&D product program
    - Task of the supplier in the program
    - Competence of the supplier
    - Nature of the collaboration in practice
    - Challenges in the collaboration

5. Sharing of information in the R&D product programs

- What is the content of information being shared with the supplier?
    - On a program level
    - On a relationship level
- Why is the information shared?
    - What are the benefits in information sharing?
    - Are there any risks in information sharing?
    - Are there any challenges in information sharing?
- How is information shared (the meeting practices and other tools used in information sharing)
- Special issues in information sharing: change management and competence transfer

6. Lessons learned

- What would you do differently in the current program?
- What would you change in the current system?

APPENDIX 3: LIST OF INTERVIEW CODING

Research Issue	First level code	Second level code	Third level code: Explaining factors	Variables
Program context	CXT			
- Industry		CXT-IND	Maturity	Specification changes
- Business unit		CXT-BU	Organization practices	Attitude towards collaboration
- Program organization		CXT-PRG	Role of the program organization program progress	Process model schedule of the program
- Product features		CXT-PRD	Guidelines Complexity and maturity	Existence, amount and usage Architecture, number of interfaces
- R&D project features		CXT-PRJ	Project progress Success factors, lessons learned, challenges and problems	Schedule of the project outcome of the collaboration
- Supplier features		CXT-SUP	Supplier competence Culture Location	Low vs. high competence Finnish vs. other Within one city/country, global
- Relationship features		CXT-REL	Length and history of relationship Supplier selection, capability Depth of collaboration (outsourcing, subcontracting) and the contract type Competence transfer	Experiences within the technology area, level of trust Selection process, level of capability Level of control and involvement Building & keeping up of competence, training

Information sharing	IS			
- General features		IS-GEN	Challenges and problems	Internal/relationship-specific/external
- Drivers/risks		IS-DRI	Strategic/operative levels	
- Content		IS-CNT	Strategic/operative content	Adequacy, frequency, openness
- Media		IS-MED	Face-to-face, email, phone, net meetings, others (reporting, hands on/on site)	Frequency, openness, participants, content, security

APPENDIX 4: AN EXAMPLE OF INTERVIEW CODING AND DRAWING CONCLUSIONS FROM THE INTERVIEW DATA

Context-dependency and information sharing

1. Relation between the nature of subcontracted task and the amount of communication (CXT-TASK and IS-GEN)

" …it is clear that there should be independent entities with the supplier. If we speak about a large supplier, and we have given them an independent entity, it means that communicating across the interface is much easier than in a case where there are no such entities and they are dependent on us." (Sub-Case 2, collaboration management)

2. Nature of product area and dependency with other product areas/programs (CXT-PRD and CXT-PRJ)

Q: "If you compare your product area X with the product area Y where I also interviewed the project manager, would you describe these as a product or entity?"

A: "The product area Y is a huge product, the biggest one. But on the other hand, it is better specified than product area X. … it functions better – the requirements in the interface, where the specification is created. There might be some changes, just like in our case, but at least it functions better, although it is a huge entity. The product area X is – it is nice to get when the other product areas are functioning, but we have stayed in a situation, where other product areas add some features and we try to keep up with them. We chase them down and try to support them. This is what we have not yet been able to manage properly in a reasonable way. In a way that we had made the requirements together."

Q: "Does it require more collaboration?"

A: "Yes, I mean with other product areas." (Sub-Case 2, project management)

3. Relationship trust and the communication challenges (CXT-REL and CHA)

Q: "Do you find that communication challenges would be due to the low level of trust?"

A: “I wouldn’t say it is a matter of trust. The problem of communication was that we could not communicate the right issues, because we didn’t know what the situation was there. That is, we would have shared certain issues, if we had only got some statement of the problems and the current state.” (Sub-Case 2, project management)

4. Relation between face to face meetings, amount of information sharing and the nature of R&D tasks (IS-MED and IS-GEN and CXT-TASK)

Q: “How critical is it to meet the supplier? Did you have many meetings with them, or could you carry it out without face to face meetings?”

A: “The basic idea is that the supplier is taken in our every-day work. If we have a project meeting, the supplier is represented: the working plans, schedules – we need the supplier in those kinds of tasks. It is problematic, if we can’t get them along. These jobs are not that independent – unfortunately it does not work if we say ‘code and test your job and tell us when it is ready.’ We have to be in constant cooperation, and when the content is changing, when problems occur, and all these codes are married to each other and they have dependencies, it follows that information must be shared all the time with everybody.” (Sub-Case 1, project management)

5. Relation between face to face meetings, competence transfer and the complexity of the subcontracted task (IS-MED and CT and CXT-TASK)

Q: “I have wondered, how is it possible that in this era of all communication media available (e.g. net meeting), the importance of physical nearness is so emphasized?”

A: “Yes, it is surprisingly important when transferring complex, technical competence. That is, if we nowadays do these kinds of operations within our company (e.g. changing competence or responsibility from one site or organization to another) it (face to face meetings) is ongoing. Actually we never do – if it is an important task – it in another way than sending one person to transfer the competence. In this area, where we had some challenges with our supplier, there was no expatriate, whom we really had needed.” (Sub-Case 1, program management)

6. Relation between the type of contract and the nature of information sharing (CXT-REL and IS-GEN)

"…In the time&material based subcontracting the resources move to work as part of our project within our team."

Q: "Is the control tightest in this, if they…?"

A: "Yes. They are part of our project team, information regarding the project work is shared just like with our own employees. Of course there are some company related confidential information issues which are not shared – the suppliers do not participate our strategy information session. But the information required in the project work is shared in a similar way." (Sub-Case 3, collaboration management)

Governance of information sharing

1. Communication challenges with the supplier versus in-house: preparing through project management practices (especially through specifications) and improving communication (CHA and IS-GEN and PRC-PRG)

Q: "I have been told that you could not communicate clearly enough what the supplier was expected to do – that is, the specifications were not clear enough."

A: "Yes.

Q: "This was due to the fact that originally you have done those specifications, and there was no such need to give detailed information in-house."

A: "Oh yes."

Q: "When they are given to the supplier, they should be more detailed. Did you have similar challenges?"

A: "No. Because we knew this problem… In fact, when the collaboration started with the supplier 2, …. There were some bad experiences of these and it was so evident that this was a communication problem: our company gives the specifications, the supplier 2 does it in a way it has understood it. And in the end the expectations and results did not match. Because of this reason we did it in the following way: the person who made this requirement was sent for a couple of days to the supplier 2. The employees there had time to internalize what we had expected. That is, we

communicated by word of mouth. And they had a chance to ask questions." (Sub-Case 2, project management)

2. Relation between collaboration success and definition of tasks (SF and CXT-TASK)

"…and the issue is how successfully the information has been sketched by the upper level documents. In my opinion, that is the most critical phase in the collaboration. That is, if these have been done clearly enough, the dependencies between other parts will clearly decrease. Or it is possible to do changes independently within your 'sandbox' without having an influence on the supplier's elements." (Sub-Case 1, project management)

APPENDIX 5: EMPIRICAL RESEARCH PROCESS

Before interviews (December 2004–January 2005)

- Introduction to the Case Company's business (R&D focus)
- Focusing the empirical research problem and research questions with the Case Company advisors
- Discussion about the case selection and key contacts in each Sub-Case

Data collection (February–April 2005)

- Open-ended, theme interviews
- Interview framework and introduction to the study (e.g., target, terminology, and scope) were sent beforehand to each interviewee (see Appendix 1)
- The interview began with an overview of the study
- 17 face-to-face, tape-recorded interviews were conducted
- 1 email interview was conducted
- 1 phone interview was conducted

Data analysis (October–December 2005)

- Altogether 350 pages of transcripted material (+ two other interview notes)
- Interview coding was created (see Appendix 3)
- Transcripted data was classified according to coding and sub-codes
- Summaries of each main research issue were generated into Excel worksheets (27 worksheets) → to create a deeper understanding of the big picture and to be able to find out the highlighted issues of the interviews
- Mind maps were drawn based on Excel summaries to figure out relations/dependencies and explanations

Data verifying

- Right after the interview an interview memo was drafted, translated into English and sent to each interviewee for verification (3 interviewees did not comment on the memo)
- Sessions with the Case Company advisors were held during the research process in the beginning, after the interviews and the preliminary analysis, and after the research summary
- Case report was sent to each program's representative for verification

APPENDIX 6: MAIN SIMILARITIES BETWEEN THE PROGRAMS AND THEIR IMPACT ON INFORMATION SHARING

Context	SUB-CASE 1	SUB-CASE 2	SUB-CASE 3	Explanation
Multisite organization	Several sites and two countries (R&D supplier was located in Finland)	Several sites and two countries (R&D supplier was located in Asia)	Several sites in one country	Makes information sharing more challenging
Guidelines	Sufficient	Sufficient	Sufficient	Improves information sharing in general
Complexity	Complex	Complex	Complex	Increases the amount of information sharing
Relationship history	Several years	Several years	Several years	Improves information sharing in general, especially its openness
The level of trust	Good	Good	Good	Improves information sharing in general, especially its openness

APPENDIX 7: DISTINCTIVE FEATURES BETWEEN THE PROGRAMS AND THEIR IMPACT ON INFORMATION SHARING

Context	SUB-CASE 1	SUB-CASE 2	SUB-CASE 3	Explanation
Maturity of the technology area	Mature	Mature	Immature	Relates to the changes in specifications, e.g., customer requirements
History of the programs in the same product family	Long	Average-length	Short	Relates to the experience of employees, the level of processes and guidelines
Size	Large	Medium-size	Small	Relates to the manageable size
Project model	Phase	Waterfall	Phase	Relates to the technology ownership and program control
Supplier capability	Existed	Increased step by step	Existed (originally limited capability due to new technology, but increased capability due to supplier management activities)	Relates to the style of information sharing (especially frequency)
Culture of the supplier	Finnish	Asian	Finnish	Relates to the nature of information sharing (especially media and style)
Selection of the supplier	Personal contacts, company culture, management style	Personal contacts, the preferences of the company	Personal contacts, evaluation of the capabilities	Relates to the style of information sharing (especially frequency)

APPENDIX 8: DISTINCTIVE FEATURES BETWEEN THE PROJECTS OF THE THREE PROGRAMS AND THEIR IMPACT ON INFORMATION SHARING

R&D PROJECTS	Task 1A	Task 1B	Sub-Project 2A	Sub-Project 2B	Project 3A	Project 3B	Explanations
Size	Large	Large	Small	Small	Small	Small	Relates to the manageable size
Contract type	FP	FP	R&R	FP	FP	FP	Relates to the level of control and amount of information sharing
Supplier experience and capability	Good	Good	Poor	Good	Good	Good	Relates to the amount of information sharing
Number of interfaces	Several	Several	Several	Several	Few	Few	Relates to the amount of information sharing
Challenging internally	Yes	Yes	Yes	No	No	No	Relates to the amount of information sharing
Independent entity	No	No	No	Yes	Yes	Yes	Relates to the amount of information sharing
Architecture	Sw	Sw	Sw	Sw	Hw	Hw	Relates to the ease of specifying the product

APPENDIX 9: SUMMARIES OF THE SUB-CASES

Sub-Case 1 interviews focused on the importance of product capability (recognition of the product ownership and the meaning of the business unit organization and the process model for the project management), the importance of the basic make-or-buy decision (why collaboration) and its implications (motivation of the employees, selection and success factors of the R&D tasks to be collaborated). The nature of information sharing in Sub-Case 1 was smooth, which was mainly due to the good processes and guidelines, and the experiences of the employees. The specification phase was emphasized as an influential factor in further information sharing and program management. The most challenging issues were the content of the documents: this was already experienced while having R&D in-house, and a lot of information was shared informally. In addition, access rights management was regarded problematic.

Sub-Case 2 interviews contributed to an understanding of which factors may influence the success of an R&D project, and the nature of the subcontracted task and its implications on the information sharing and program management. The interviewees also commented on issues that are faced when working with the supplier coming from a different culture. Some challenges with the supplier also related to the capability of the supplier, in which there could have been room for improvement. This was partly a consequence of high person turnover during the program. Information sharing was most challenging in Sub-Case 2. Reasons were in poor planning and it was probably too widely expected that the supplier can get required information independently. Furthermore, the supplier was not very active in asking for information, and there was also a language challenge between the companies. In Sub-Case 2 face-to-face contacts were regarded of importance, partly because of the culture, partly because of the complex development tasks. The supplier wished information sharing to take place through an onsite coordinator instead of other contacts between the project members.

Sub-Case 3 interviews were conducted last, and it seemed from the beginning that this program was the most successful among the three programs. Thus, the interviewees commented much on the success factors of the program. Since Sub-Case 3 interviews were conducted last, it became natural to ask more specifically about factors that had influenced the program's success. Only few challenges in information sharing were reported in Sub-Case 3. The circumstances of the program (the supplier located in the same city) enabled having many face-to-face meetings, and most issues were handled in these meetings. Another emphasized area was the collaboration management, which was handled more thoroughly than in Sub-Cases 1 and 2. The explanation relates to the selected interviewees: among Sub-Case 3 interviewees there were one relationship manager and one partner manager, who were in other programs replaced by project managers.

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