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Implications of Profit- and Risk-sharing Attributes for Collaboration Performance in Software Development

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ABSTRACT

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Keywords: profit sharing, risk sharing, collaboration performance

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Research of profit- and risk-sharing implications aimed at improving collaboration performance has been focused on parcelled goods manufacturing. In this context, research has shown that profit- and risk-sharing is an indicator for increasing collaboration performance. The present study investigates the influence of attributes of profit- and risk-sharing on collaboration performance in the context of software development.

The study is based on three research questions. Together, the questions cover the definition of collaboration performance by collaboration participants, and influences of attributes of profit- and risk-sharing on collaboration performance in the context of software development in the telecommunications industry. Data for this study was collected from respondents in two OEM companies and their supplier companies engaged in software development in the telecommunications domain. On the basis of this data, the definition of collaboration performance was constructed by content analysis. Through structural equation modeling, it was shown that profit-sharing was not having influence on collaboration performance. Instead, some attributes of risk-sharing and sharing of decision-making were seen as factors increasing collaboration performance in software development. The more detailed analysis of these attributes shows that in different collaborator roles (OEM, supplier), attributes of risk-sharing and decision-making sharing are experienced to influence collaboration performance differently.

This study contributes the existing theory and research by defining collaboration performance and identifying the influence of profit- and risk-sharing attributes on collaboration performance in the specific context of the research. The study also contributes to the discussions of different interorganizational relationship concepts. From a managerial perspective, the study contributes by illustrating the breadth in which collaboration performance is experienced, as well the differences in the viewpoints of OEM and supplier companies. Also, it provides more information on deciding whether companies should deploy profit- and risk-sharing on an increasing scale in future.

TIIVISTELMÄ

Pihlajarinne, Hanna-Maria (2009): Implications of profit- and risk- sharing attributes for collaboration performance in software development. Teollisuustalouden laitos, Tampereen teknillinen yliopisto.

Asiasanat: tuottojen jakaminen, riskien jakaminen, yhteistyön suoritustaso

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Tutkimus tuottojen ja riskien jakamisen vaikutuksista yritysten välisen yhteistyön suoritustasoon on tähän asti keskittynyt kappaletavaratuotannon kontekstiin. Tässä kontekstissa tutkimustulokset ovat näyttäneet tuottojen ja riskien jakamisen vaikuttavan yhteistyöhön suoritustasoa lisäävästi. Tämä tutkimus käsittelee tuottojen ja riskien jakamisen vaikutuksia yritysten välisissä yhteistyösuhteissa ohjelmistotuotannon kontekstissa. Tutkimus tarkastelee sitä, onko tuottojen ja riskien jakamisella myös tässä kontekstissa positiivinen vaikutus yritysten väliseen suoritustasoon.

Tutkimus perustuu kolmeen tutkimuskysymykseen. Yhdessä ne kattavat yritysten välisen yhteistyön suoritustason määritelmän, selvittävät tuottojen jakamisen ominaispiirteiden, riskien jakamisen ominaispiirteiden ja koetun yhteistyön suoritustason väliset suhteet telekommunikaatioalan ohjelmistotuotannossa. Tutkimuksen aineisto kerättiin kahdelta laitteiden alkuperäisvalmistajalta ja näiden valituilta toimittajajoukoilta. Aineiston perusteella yhteistyön suoritustaso määriteltiin vastauksissa toistuvien teemojen avulla. Tärkeimpänä löydöksenä tutkimuksessa vahvistui rakenneyhtälömallinnuksen avulla se, ettei tuottojen jakamisella ollut tilastollisesti merkittävää suhdetta koettuun yhteistyön suoritustasoon. Sen sijaan osalla riskien jakamisen ominaispiirteistä ja päätöksenteon jakamisen ominaispiirteistä tilastollisesti merkittävä vaikutus yhteistyön suoritustasoon löytyi. Tarkempi aineiston analysointi osoittaa, että tekijöiden koettu vaikutus yritysten väliseen suoritustasoon riippuu edustetun yrityksen roolista (alkuperäinen laitevalmistaja, toimittaja).

Tutkimus kontribuoi olemassa olevaan tutkimukseen määrittelemällä yhteistyön suoritustason ja tuottojen ja riskien jakamisen vaikutukset suoritustasoon tässä spesifisessä kontekstissa, josta ne ovat tähän asti puuttuneet. Tutkimus kontribuoi myös keskusteluun erilaisista yritysten välisistä suhteista ja niiden määritelmistä. Tutkimuksella on implikaatioita myös telekommunikaatio- ja ohjelmistotuotannon liiketoimintaan. Yhteistyön suoritustason käsitteen laaja määritelmä ja näkemyserot joita alkuperäisillä laitevalmistajilla ja toimittajilla tähän on, tuovat lisätietoa tässä rajapinnassa työskenteleville. Tuottojen ja riskien jakamisen käyttöönottamiseen liittyvään päätöksentekoon tutkimus tarjoaa tietoa päätöksenteon pohjaksi.

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Writing a doctoral study is sometimes compared to running a marathon, my favourite hobby. And indeed -just like after completing a marathon, also after completing this study I feel great enjoyment and gratefulness for finally being here. Finishing this study would not have been possible without the support and encouragement of several people who I want to thank here.

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29th of November, 2009
Aitolahti, Näsijärvi lakeside, Tampere

Hanna-Maria Pihlajarinne

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1. INTRODUCTION

1.1. Background of the research

The implications of profit- and risk-sharing have been widely studied in the context of parcelled goods manufacturing. These studies have found profit- and risk-sharing to increase collaboration performance in the context of interorganizational relationships (e.g. Foros et al., 2009; Lakhal, 2006; Lejeune and Yakova, 2005; Mentzner et al., 2001; Simatupang and Sridharan, 2002; Kamrad and Siddique 2004; Cachon and Laviere 2005; Wang et al 2004). Partnership type of relationships, which often include the aspects of profit- and risk-sharing, are also found to produce added value beyond other relationship types in the literature (see e.g. by Brinkenhoff, 2002a; Shah and Singh, 2001).

In software development in the telecommunications domain, partnership types of relationships have been the focus of interest, in tune with the trends in the literature. However, there is no scientific research available on the implications profit- and risk-sharing on collaboration performance in this context.

Software development in the telecommunications domain has characteristics quite different from the characteristics of parcelled goods manufacturing. It represents the common characteristics of software development well. Complexity, systemic nature, structure of many interdependent subproducts, existence of multiple migration paths in development, short product life cycles, global distribution, high technology, and high product values are identified as the characteristics of the software products in the telecommunication industry (Blomqvist, 1999; Collin, 200, Hirvensalo, 2003). In the field of telecommunications, radical innovations are rapidly emerging in the industry (Parolini, 1999). The industry is simultaneously managing different technology generations and emerging standards, and there is much tacit knowledge existing in product development (Blomqvist, 2002). Competition between companies is

knowledge-based (Blomqvist, 2000). The environment is unstable because of the increase in subfields and entry of new players into the industry (Edelmann, 2001). These characteristics make software development distinct from manufacturing of parcelled goods. Because of these differences, the obvious question would be if the generalization of the results achieved for profit- and risk-sharing in parceled goods manufacturing is applicable in the context of software development.

1.2. The research questions

This study is based on three research questions that are derived from the gaps in research identified in the previous section. To be able to analyze the implications of a parameter on collaboration performance, it needs to be understood and defined. In the existing studies, factors influencing performance are studied in the context of strategic groups, interorganizational relationships, and software development projects (e.g. Lempments, 2007; Chan and Qi, 2003; McNamara et al., 2003) but there are no definitions of software development collaboration performance available. The first research question focuses therefore on the definition of software development collaboration performance and is defined as:

> ***Research Question 1:*** *How is performance defined in collaborative software development by participants of collaboration?*

Profit- and risk-sharing were found to increase the success and performance of interorganizational relationships in the manufacturing of parcelled goods (e.g. Foros et al., 2009; Lakhal, 2006; Lejeune and Yakova, 2005; Mentzner et al., 2001; Cooper and Ellram, 1993; Simatupang and Sridharan, 2002; Das and Teng, 1998; Day, 1995; Jarillo, 1988; Kamrad and Siddique, 2004; Cachon and Laviere, 2005; Wang et al., 2004). In this study, profit- and risk-sharing are analysed as possible performance predictors for software development collaboration. These factors are studied together with another factor, sharing of decision-making, which is considered as an instantiation of profit- and risk-sharing utilization. The second research question can be stated as:

Research question 2: *What are the attributes of risk- and profit-sharing and sharing of decision-making influencing performance in software development collaboration?*

Some of the research of interorganizational relationships has concentrated on the roles in a defined collaboration, i.e. supplier and original equipment manufacturer (e.g. Walter et al., 2001; Ulaga, 2003). To understand the dynamics of the influences of the attributes of risk- and profit-sharing and sharing of decision-making on the collaboration performance in this specific context, the third research question is defined as:

Research question 3*: Does the collaborator role change the influences of attributes of risk- and profit-sharing and sharing of decision-making with regard to performance in software development collaboration?*

The answers for these research questions that include both "what" and "how" elements are found mixed methods research approach. In mixed method approach both quantitative and qualitative methods are used. The data for the research is collected by a questionnaire including both open and closed questions, targeted to the collaboration participants in two OEM companies and groups of their suppliers. The research questions and the related research methods that are used for finding results on them are listed in Table 1-1. The analysis includes both statistical and text analysis. As the answer for the first research question, the collaborative software development performance definition by participants of collaboration is analyzed qualitatively by content analysis. For the second research question, the attributes that are influencing into performance are analysed quantitatively using structural equation modeling (SEM). The answer for third research question, the differences in the implications between the respondent groups, are analysed quantitatively using multivariate analysis of variance (MANOVA).

Table 1-1. Research questions, research methods and related results of this study

Research question	Research method	Result
1. How is performance defined in collaborative software development by participants of collaboration?	Content analysis; finding themes from open answers	Themes included in the definitions of software development collaboration success
2. What are the attributes of risk- and profit-sharing and sharing of decision-making influencing performance in software development collaboration?	Structural equation modeling (SEM)	Structural equation model describing the attributes influences
3. Does the collaborator role change the influences of attributes of risk- and profit-sharing and sharing of decision-making with regard to performance in software development collaboration?	Multivariate analysis of variance (MANOVA)	Statistically significant differences between the respondent roles (OEM, Supplier)

1.3. Structure of the study

This study is organized into six chapters, as illustrated in Figure 1-1. Chapter 1 (the present chapter) describes background of the study by presenting the research gap in the existing literature. The three research questions of this study and the structure of the study are defined, as well as the main concepts that are used in this study.

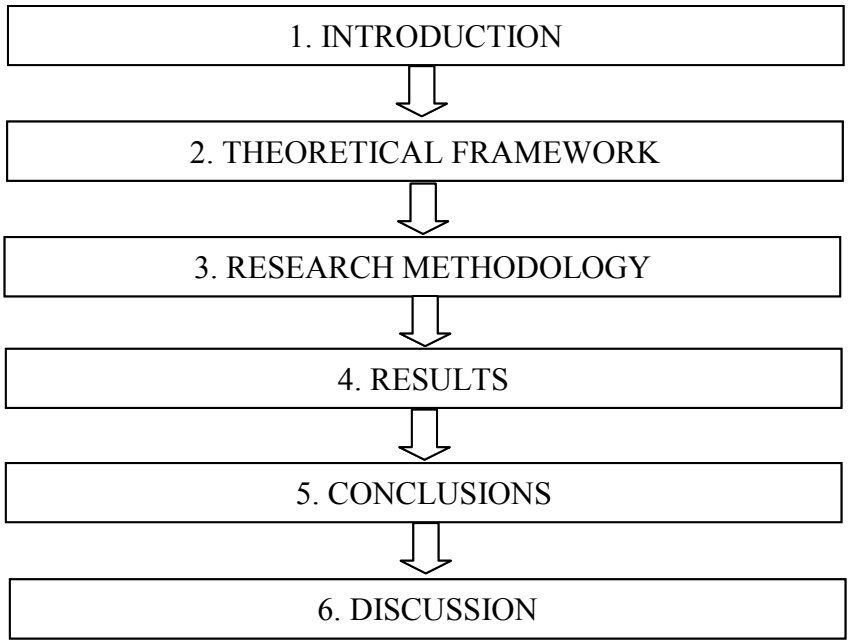

Figure 1-1. The structure of this study

Chapter 2 presents the theoretical framework for the study. First, the business networks are reviewed as a background for bilateral relationships. Then, the different bilateral relationship types are analyzed, followed by the review of the concept of performance in the context of bilateral relationship. Further, the concepts of profit- and risk-sharing in the different relationship types and their implications in the current research are reviewed. Last, the hypotheses for this study are developed on the basis of this literature review.

Chapter 3 describes the research design. The rationale for the choices of research strategy, research methods, and data sampling methods that are used in this study are given. The main characteristics of the research methods in use are described, together with the expedients that are used for decreasing the threads of validity and reliability of the results to be achieved.

Chapter 4 represents the results that are achieved by the empirical research of this study. The results are presented in the order of the research questions. First, the definition of collaboration performance in software development is analyzed. Then the attributes of profit- and risk-sharing and sharing of decision-making influencing the collaboration performance are discussed. Finally, the differences between suppliers and original equipment manufacturers are provided.

Chapter 5 presents the conclusions from literature review and empirical study. The chapter is structured on the order of research questions. The answer for each research question is defined and discussed.

The last chapter discusses the contribution of the study and evaluates the reliability, validity, and limitations of the study. Also, the recommendations for further studies are given.

1.4. Definitions

This chapter includes the key definitions used throughout the study to avoid conceptual misunderstanding. The concepts are discussed in the order of their appearance in the study.

Collaboration: In this study, collaboration is defined as a higher level concept of different interorganizational relationships, which include all kinds of arrangements between cooperating companies. This interpretation of this type of collaboration is in agreement with the definitions by Hibbert et al. (2008) and Edelmann (2001).

OEM: Original Equipment Manufacturer

*Partnership***:** In this study, the term partnership is used to identify cases of bilateral relationships that include profit-sharing. With profit-sharing, risk-sharing is assumed to be also included in the relationship as a latent variable. This interpretation of the concept is in agreement with the definitions by Ellram and Edis (1996), McIvor and McHugh (2000), and Lambert et al. (1996).

Profit-sharing: The concept of profit-sharing is a higher level concept defined for different activities by which the companies belonging to some interorganizational relationship share the positive results achieved in the relationship. In the existing literature, these activities are labeled as incentive alignment, reward sharing, revenue sharing, or benefit sharing.

Risk-sharing: The concept of risk-sharing in this study is defined as the context in which companies share the different negative outcomes to which the companies belonging to same interorganizational relationship are exposed to.

Subcontracting: Subcontracting is used in this study to illustrate interorganizational relationship that has very near to pure exchange. There are no elements of co-development or creation of new value together included in subcontracting. This

interpretation of the concept is in agreement with the definitions by Lehtinen (2001), Assman and Teade (2004) and Ali-Yrkkö (2001).

Supplier: Supplier is used here to describe the role of a company being the counterpart for OEM company in the interorganizational relationship. A supplier company delivers its output for the end-product of OEM company.

2. THEORETICAL FRAMEWORK

2.1. Business networks as a background for bilateral relationships

2.1.1. Drivers for companies building networks

Linking and networking of companies together for a common purpose into business networks, which are described in more detail in following sections, has led to a new form of competition across global markets. Groups compete against other groups (Gomes-Casseres, 1994). Because of their capacity for information processing and flexible governance, networks adapt to the current knowledge-rich competition environments better than hierarchical organizations. A company's ability to influence and leverage various networks impacts its market and financial performance (Möller et al., 2003). Actions and performance of the companies are influenced by their position in the strategic groups (McNamara et al., 2003).

Companies have built business networks because of the changes in companies and their environments in the last decades. In the literature, there are different classifications of these changes. The changes can be divided into three categories as changes in the geopolitical order, changes in technologies (new technologies), and sociodemographic and cultural evolutions as proposed by Parolini (1999). From a different viewpoint, the changes can also be categorized as more complicated business environments, rapid changes in technology and consumption cycles, and the globalization and acceleration of business operations (Möller et al., 2004). A study by Tang (1999) identified the global economy and the growing complexity of products and services, their design, production, and delivery as the main drivers for establishing business networks. The important role of information technology and the globalization of markets and production has been emphasized by Normann and Ramirez (1993).

The environment is changing constantly, as new technologies emerge, and product requirements and their variety change. Competition is time-based and requires continuous innovation. The prevailing competition is far more dynamic, and making more productive use of the inputs and continual innovation provide competitive advantage (Porter, 1998). Modern competition depends on enhanced productivity and innovation. Productivity is dependent on how companies compete, not on the particular fields in which they compete.

Products are more complex than before and, because they are usually systemic in their nature, there are many interoperability requirements for them. Future development and demand is difficult to forecast. A large number of possible migration paths are available for product development, which at times could lead to emergence of entirely new industries. During the last decade, industry barriers have become unclear. For example, mobile phone manufacturers are currently competing with music player and camera manufacturers. In this kind of environment, partnerships have an important role, but the cooperation between partnering companies is different from the one in Porter's value chain model (Porter, 1984) where the competitive advantage of a company depends on the company's understanding of how the company fits in the overall value system.

These changes in the business environment have changed how companies need to work together. Battles over technical standards, the increasing importance of the global scale, and new technologies create links between formerly separate industries, as identified by Tang (1999). In 1980s, it was already predicted that greater cooperation will be required, and ideas that are found to be effective in a homogeneous environment will not effective in the new environment for future software development in the telecommunications industry (Sugioka, 1988).

2.1.2. Business networks in general

A network can be defined as a "set of items, which we will call vertices or sometimes nodes, with connections between them, called edges" (Newman 2003, p. 168). In the context of companies working together, a network is used to describe the different

forms of companies, agents, and their relationships. Therefore, a network describes relationships of a company with other companies. For example, the study by Möller and Törrönen (2003) defines a network of organizations as any group of organizations or actors that are interconnected in relationships.

Networks exist in different levels of economics. A good division was proposed by Möller et al. (2004) who divided network levels into of entire economics (level 2, also called as macrolevel networks) and company focus (level 1), as illustrated in Figure 2-1.

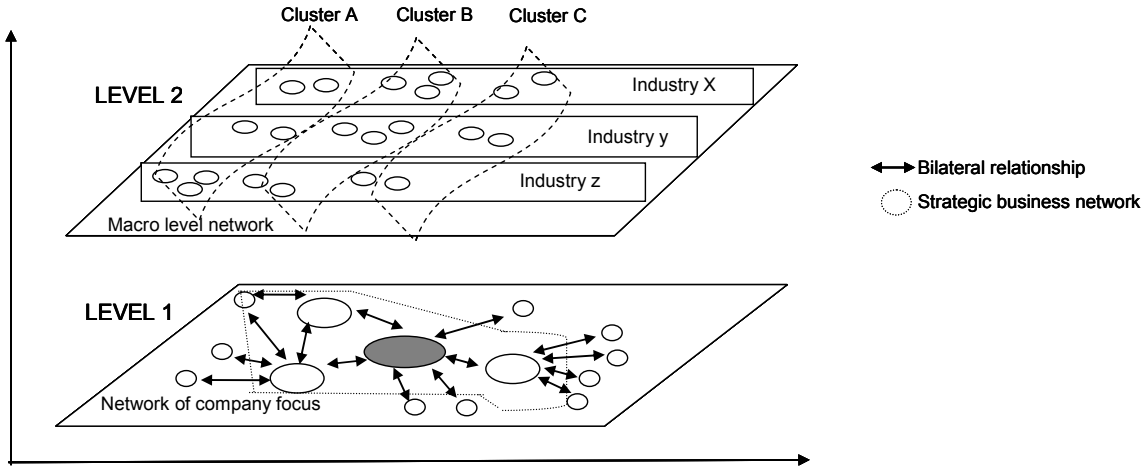

Figure 2-1. Levels of networking according to Möller et al. (2004, p.27)

Networks in these two levels are linked to each other. The networks in level 1 are building blocks for the networks in level 2. The bilateral relationship of two companies in level 1 is the basic element of networking. In the context of this study, the highest industry cluster can be defined as the information and telecommunication technology (ICT) cluster that includes both manufacturers of mobile devices and telecommunication networks that belong to the telecommunications industry. In the level 1, there are networks that the original equipment manufacturers (OEMs) have constructed to achieve their strategic targets; these networks consist of bilateral relationships, which are the focus of this study.

The terminology used to define business networks is not consistent in the literature. Various terms are used to describe business network arrangements; some of them have the same scope, while others have different scopes. Research has proposed four characteristics of business networks and distinguished business networks from general

networks of companies (Möller et al., 2004). These characteristic are as follows: (1) three or more companies belong to the network, (2) the network is consciously constructed and objective-oriented, (3) the network has its own targets that direct its operations while all participating companies have their own targets, and (4) the participating companies have their own roles with agreed responsibilities, risk-taking, and earnings principles.

Different network structures and types have been classified by Kumar and van Disse (1996), Cheng and Kam (2008), Möller and Svahn (2003), Todeva and Knoke (2005), and Camarinha-Matos et al. (2009). These concepts have different views on the number of participants it takes to form a network and the roles of the companies in networks. In all these classifications, the networks consist of bilateral relationships that can be considered as the building blocks of all the different networks. In the following sections, some forms of networks that are widely discussed in the literature are reviewed.

2.1.3. Strategic groups

A strategic group can be defined as a set of firms within an industry that are similar to one another and different from firms outside the group in one or more key dimensions of their strategies, and, more precisely, as a cluster or group of firms that follow similar strategies in terms of the key decision variables (Porter, 1979). According to the study by Dranove et al. (1998), a strategic group exists only if the performance of a firm in the group is a function of group characteristics. Their study argued that the concept of a strategic group is important only if there is a relationship between the group's conduct and the firm's performance. Strategic groups can therefore be differentiated from competitive groups in which firms compete against each other (Reger and Huff, 1993).

The structure of strategic groups and their effects on strategic actions and performance has been one of the aims of various research studies (see e.g. MacNamara et al., 2003; Reger and Huff, 1993). There is a tendency to define core firms and secondary firms inside the strategic groups. Strategic group consists of core firms that define the group's position and secondary firms that are aligned with core firms in many essential respects

and also make some unique strategic decisions. Core firms follow the group strategy closely, and secondary firms follow it less closely (Reger and Huff, 1993).

The term *strategic network* is widely used in the literature and has a very similar definition to the term strategic group. A strategic network can be defined as a long-term purposeful arrangement of several separate for-profit companies with a hub company that sets up the strategic network and takes an active role in maintaining it (Jarillo, 1988). The perspective of time is included into definition by Jarillo and Ricart (1987), when a strategic network is defined as a network of distinct but related for-profit organizations that gain or sustain a competitive advantage in the long term over their competitors outside the network. Mobility barriers can be seen as boundaries of strategic groups that limit entry into the groups by retarding imitation. As the mobility barrier becomes higher, the strategic group's ability to prevent imitation and the group member's potential for profit become greater (Porter, 1979). The paper by Porter also argued that the degree of rivalry within a group depends on the structure of the group. Members of large groups with significantly different scales and risk preferences are more likely to be rivals than members of smaller groups.

2.1.4. Value net

Porter's model of the value chain, described in 1980s, does not take all the factors in a new business environment into account (Normann and Ramirez, 1993; Parolini, 1999). To make the model respond more to the needs of the new business environment, several new concepts have been proposed to illustrate the current environment better. The concept of *value net*, presented by Cinzia Parolini (1999), can be seen as an updated concept of Porter's value chain. An example of the value net is illustrated in Figure 2-2.

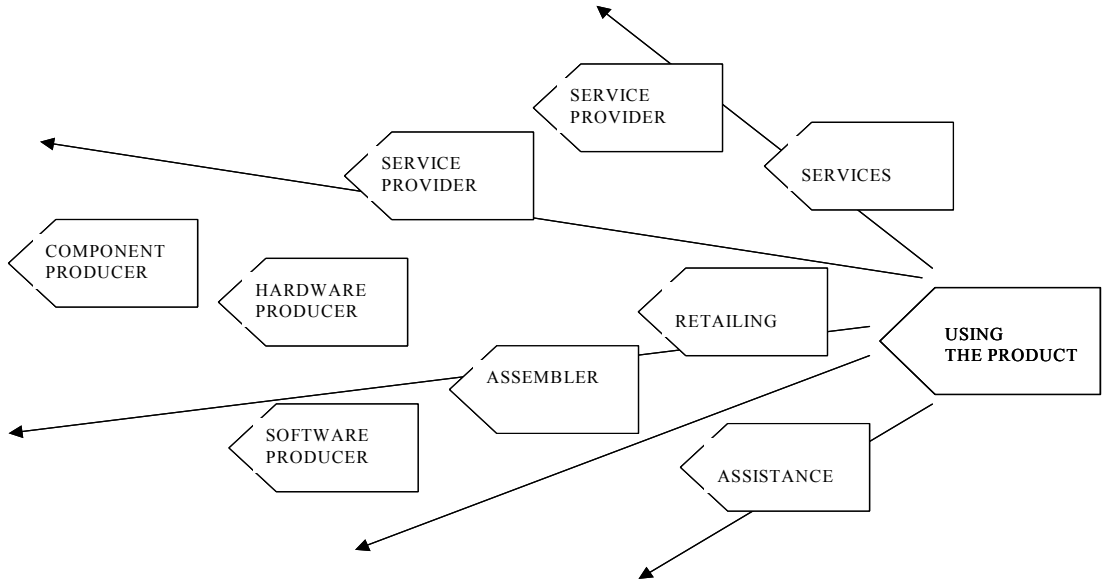

Figure 2-2. Example of the value net, modified from Parolini (1999, p.71)

The value net consists of a set of activities that are not sequential but in many cases parallel from the end-user's point of view. The value net does not make any boundaries between the companies; it describes the activities as the end-user sees them.

2.1.5. Other concepts for company networks

In addition to previous concepts, various terms describe these linkages and networks of companies or value nets in the area of parcelled goods. Concepts that are used most are briefly discussed in this chapter.

Supply chain can be defined as "a network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer" (Christopher and Ryals, 1999, p. 3). A broader definition is given by Lehtinen (2001). She defines supply chain as a flow of all activities, organizations, and associated information that transforms and builds the product from raw materials for the end user. The definition by Mentzner et al. (2001) adds agents to the supply chain when it is described as a set of three or more entities that are directly involved in upstream and downstream flows of products, services, finances, and/or information from a source to a

customer. The concept of supply chain has both very broad and narrow definitions in the literature. For example, the definition by Cooper et al. (1997) defines the supply chain as broad as an integrative philosophy to manage the total flow of a channel from the earliest supplier of raw materials to the ultimate customer, and beyond, including the disposal process. As an example of narrow definition, supply chain has been defined by Camarinha-Matos et al. (2009) as a stable long-term network of enterprises, each having clear roles in the manufacturing value chain, covering all steps from initial product design and the procurement of raw materials until a finished product is delivered to a customer.

The concepts of the supply chain and the value chain can be seen to have a quite similar nature. The value chain is more of a theoretical model for the activities and participants. The supply chain is a practical expression, and the term supply chain is more often used in parcelled goods. The supply chain is a chain of activities, and there might be several complementary supply chains available. The product is always delivered through one phase at a time. Supply chains can be combining and dividing if the phase products are integrated or distributed inside supply chains.

The wide variety of typologies of supply chain configurations is described by Lejeune and Yakova (2005). The study distinguished four different supply chain configurations. The first configuration is communicative. This kind of supply chain is not managed, but it still exists and involves as-needed short-term relationships. Trust is limited to its reliability, decision-making is myopic, and each entity is totally independent and fully autonomous. There is no goal congruence inside the supply chain. The second configuration is a coordinated hierarchy of entities in the supply chain that is dominated by the supply chain leader who has superior negotiation power. Reciprocity in this kind of supply chains is very loose. The decision-making process is myopic, and a moderate goal congruence exists. The objectives of the dominant company are imposed on its counterparts, which are dependent on the dominant company to such a degree that they are forced to modify their objectives to match those of the dominant entity. The third configuration consists of collaborative entities that agree on a set of commonly defined objectives and use their complementary assets to gain a long-term competitive advantage. Decision-making is parity-based, and the common objectives are defined. The last configuration, a co-opetitive supply chain, combines cooperation and

competition. In a co-opetitive supply chain, the competitors can benefit when they work together. There is deep interdependence inside the supply chain. Common development of new technologies requires true goal congruence among entities, which have little concern about others' opportunistic behaviour. The decision-making process is parity-based and dyadic.

One special arrangement of cooperation between an OEM and several supplier companies is the *keiretsu*, a successful and close cooperation that is developed by Japanese car manufacturers. In the keiretsu, the OEM works very closely with its suppliers and encourage suppliers to learn, improve the production, lower the costs (Liker and Choi, 2005), and conform to a keiretsu structure. In the keiretsu, the suppliers are organized as tiers around the OEM. There are four different maturity levels at which the suppliers can operate. Most of the first-tier companies have the highest maturity level, and they are integrated into product development with early involvements and quest engineers with the OEM (Morgan and Liker, 2006). Keiretsu can be seen as the Japanese "society of business" (Cooper et al, 1997). One study compared the keiretsu structure with alliances, and found out that in a keiretsu, companies have long-standing and broad-based relationships with one another and the companies help one another in various ways and in multiple fields of business. Alliances are more focused. Their objectives are more strategic, and their members' roles are more narrowly tailored (Gomes-Casseres, 1994).

Clusters are most often differentiated from other forms of intercompany relationships by the characteristics of geographical concentrations (Porter, 1998; Patti, 2006). Clusters are defined as "geographic concentrations of interconnected companies and institutions in a particular field" (Porter, 1998, p.78). According to Porter, clusters often extend downstream to channels and customers, and laterally to manufacturers of complementary products and companies in industries related by skills, technologies, or common inputs. Many clusters include governmental or other institutions (e.g., universities). Because of their nature, clusters benefit from both competition and cooperation. Competition forces all members of the cluster to improve their efficiencies to control costs and look for ways to enhance their differentiation capabilities. Competition is seen vital for the cluster; without it, the cluster will fail. The increased productivity leads companies in the cluster to have better access to employees,

suppliers, public institutions, and specialized information; it also increases the availability of complementary products and services, and improves motivation and measurement (Patti, 2006). In addition, clusters affect competition by driving the direction and pace of innovations, and stimulate the formation of new businesses that strengthens the cluster (Porter, 1998).

The terms *extended enterprise* and *collaboration network* are also used to denote the company and its partners (Dyer, 2000; Camarinha-Matos et al., 2009). In these concepts, a dominant enterprise extends its boundaries to all or some of its suppliers. The term *focused enterprise* was used in similar meaning by Östring (2003). The terms *virtual company* and *virtual enterprise* are also used in literature. A virtual company can be defined as integrated cluster of companies (Hamm, 2007). A virtual enterprise can be defined as "a network of independent organisations that jointly form an entity committed to provide a product or service" (Karjalainen et al., 2004, p.89). Kumar and van Dissel (1996, p. 279, p. 281) defined interorganizational systems as "planned and managed cooperative ventures between otherwise independent agents" that "exist in order to support and implement cooperation and strategic alliances between two or more organisations".

2.2. Bilateral company relationships

Bilateral relationships between companies are building blocks for network structures and the focus of this study. In this section, the different terms related to collaboration or purchasing activities between two companies are discussed first. Second, frameworks for classifying different relationships are discussed and are followed by the analysis of different relationship concepts.

2.2.1. Terminology related to purchasing activities

This section analyzes the concepts related to different activities concerning interorganizational relationships. The concepts describing the interorganizational relationships are analysed in the following sections.

Sourcing can be defined simply as ”purchasing of components” (www.webster.com). It is usually used in the absence of a cooperative element. However, in practice, sourcing can be used to mean various kinds of relationship models between the two companies and an organizational function that manages suppliers. A study by Yu et al. (2009) defined four different types of sourcing on the basis of the existing studies: sole sourcing, single sourcing, dual sourcing, and multiple sourcing. Sole sourcing usually refers to a buyer–supplier relationship in which the buyer has only one supplier in its supplier base. The difference between sole sourcing and single sourcing is that in single sourcing, the buyer chooses one supplier from its supplier base that includes several other suppliers. Dual sourcing refers to a situation where the buyer uses two suppliers, one of whom may dominate the other in terms of the business share, price, and reliability. Similarly, in multiple sourcing, the buyer uses several suppliers and plays one supplier against another to achieve a price advantage. Yu et al. (2009) further analyzed single sourcing and dual sourcing with regard to parcelled goods and found that both set-ups can be effective, depending on the magnitude of the disruption probability. In this study, the term sourcing is used as measurement operationalization to generally describe the activity of the OEM that buys software development work from a supplier company.

Subcontracting can be defined as “engaging a third party to perform under a subcontract all or part of the work in an original contract” (www.webster.com). A subcontracting chain can be defined as a part of the whole supply chain from raw materials to finished products (Lehtinen, 2001). In subcontracting, work is done by the subcontractor according to the specifications of the OEM; therefore, no co-development or new value creation is included. The nature of subcontracting is usually considered as most exchange-type relationship after sourcing (Lehtinen, 2001; Assman and Teade, 2004; Ali-Yrkkö, 2001). However, there is no consensus on this aspect, for example it is stated that subcontracting can sometimes fulfil the characteristics of a strategic

partnership (Mattila, 1997). Especially this can happen in situations where no other subcontractor is available for the manufacturer.

The existence of subcontracting can be found in multiple layers in wider set-ups of interorganizational relationships. Subcontracting networks can be seen as one instantiation of these. Subcontracting networks are arrangements of "inter-linked firms where a subcontractor negotiates its suppliers' long-term prices, production runs, and delivery schedules" (Todeva and Knoke, 2005 p. 214). It has been argued that this kind of set-ups can potentially lead to an indirect contact with the customer and cause problems in situations where subcontractors do not necessarily feel responsible for the final product or the customer is not aware of the risks created by his dependency on subcontractors at all the levels (Assmann and Teade, 2004). It has been also doubted that subcontracting is not a symptomatic form for organizations that resemble networks more than hierarchies (MacKenzie, 2008).

In this study, term subcontracting is used as exchange –type of sourcing relationship. There are no elements of co-development or creation of new value together included in subcontracting. This interpretation of the concept is in agreement with the earlier definitions by Lehtinen (2001), Assman and Teade (2004) and Ali-Yrkkö (2001).

The term *collaboration* is derived from the Latin word *collaborare*, which means to labor together (www.webster.com). The literature shows two conceptualizations of collaboration (Min et al., 2005). In one, collaboration is seen as an interorganizational business process; in the other, it is a foundation of interorganizational relationships. In interorganizational relationships, collaboration can be seen as a higher level concept that includes all kinds of arrangements with cooperating companies. This interpretation of the concept is made, for example, by Hibbert et al. (2008) and Edelmann (2001). The collaboration definition by Hibbert et al. (2008) includes a range of interorganizational arrangements such as alliances, joint ventures, partnerships, and networks. In the definition by Edelmann (2001), collaboration includes interorganizational arrangements as joint venture, university institute agreements, collaborative R&D agreements, and research consortia.

In the study by Camarinha-Matos et al. (2009), the concepts of collaboration and cooperation, that are often confused, were compared. It was found out that cooperation includes communication, information exchange, adjustments of activities, and sharing resources to achieve compatible goals. Collaboration is a more demanding process where agents jointly generate value, including the process of shared creation. This implies sharing risks, resources, responsibilities, losses, and rewards. Collaboration is also considered to differ from cooperation in its strategic aspect: cooperation is operative, but collaboration is strategic (Clarke-Hill et al., 1998). In consonance, the analysis by Kanter (1994) defines the differences between collaboration and exchange. Companies create new values together in collaboration, while in exchange, companies get something back from what they have put in. Numerous discussions and studies are available related to collaboration, and it is observed that collaboration is rarely utilized fully in practice (Min et al., 2005). Collaboration has been defined through cooperation between the companies, as enunciated by Narus and Anderson (1996); in this context, collaboration is the cooperation between independent, but related, firms that share resources and capabilities to meet their customer needs. The aspect of negotiation power is included into the collaboration definition by Kampstra et al. (2006) who propose that in collaboration, there are two equally empowered companies: a major manufacturer and a major retailer. Min et al. (2004, p. 245) suggest that collaboration should be defined through "firm's culture of working together with other firms toward a common set of goals that bring mutual benefits to a partnering relationship".

Collaboration can be further defined in the literature by its characteristics. Collaborative culture that includes trust, information sharing, openness, communication, and mutuality has been defined as collaboration characteristics by Barrat (2004). Mutuality refers here to mutual benefits, mutual risk sharing, and respect. Openness and honesty further develop trust, respect, and commitment. Collaboration should be driven by the supply chain metrics and have joint decision-making, aligned processes, cross-functional activities, and committed resources. The characteristics of risk and profits are also included in collaboration by Min et al. (2005), by defining these to be the drivers for companies entering into collaborative agreements. Pisano and Verganti (2008) and Barratt (2004) share the same view as both financial and nonfinancial incentives were seen important factors.

Collaborative processes include joint decision-making (Stank et al., 2001) and joint problem-solving (Spekman et al., 1998) as a natural extension of sharing information among independent supply chain partners (Sabath and Fontanella, 2002; Stank et al., 1999; Barratt, 2004). As such, a collaborative supply chain involves "two or more independent companies (that) work jointly to plan and execute supply chain operations with greater success than when acting in isolation" (Simatupang and Sridharan, 2002, p. 19). Simatupang and Sridharan (2005a) proposed a collaboration index to measure the level of collaborative practices and verified that the collaboration index is positively associated with operational performance. This collaboration index included three dimensions of collaboration. The first dimension is information sharing that makes relevant information available to all decision makers. The second dimension is decision synchronization, which enables decision-making jointly in planning and operational contexts. The third dimension is incentive alignment, which means sharing costs, risks, and benefits between the companies.

The long-term purpose of collaboration can be seen as optimizing profits for all members in the chain and creating a competitive advantage (Narus and Anderson, 1996). According to Pisano and Verganti (2008), different modes of collaboration involve different strategic trade-offs. It has also been seen that different levels of collaborative practices imply different levels of operational performance achieved by the members in the chain (Simatupang and Sridharan, 2005b).

In this study, *collaboration* is defined as a higher level concept of different interorganizational relationships, which include all kinds of arrangements between cooperating companies. This interpretation of this type of collaboration is in agreement with the definitions by Hibbert et al. (2008) and Edelmann (2001).

2.2.2. Frameworks for bilateral relationships

The nature of different bilateral relationships is also studied when defining frameworks for classifying the relationships. The frameworks represented here are constructed on the basis of the relationship depth, the supplier's negotiation power, the strategic

importance for the buyer, the power distribution, and levels of integration and governance formalization.

A supplier strategy continuum is represented by Ali-Yrkkö (2001), which is illustrated in Figure 2-3. This continuum illustrates the relationships between two companies that are classified according to their depth.

Figure 2-3. Supplier strategy continuum from Ali-Yrkkö (2001, p. 44)

According to the supplier strategy continuum, the strategic partnerships pave way for the deepest cooperation between two companies. Price competition-based subcontracting represents the shallowest relationship between the two companies. Between these two extremes, there are intermediate levels of partnership that are applicable to the supplier strategy formulation. Further, Ali-Yrkkö (2001) asserts that the motive for sourcing has changed from pure subcontracting to partnership relationships, and that the strategic partnerships would increase in the future.

A similar framework of relationships based on the relationship depth is illustrated by Lambert et al. (1996). The model is illustrated in Figure 2-4. Similar to the framework of Ali-Yrkkö (2001), in the left-hand side is the arm's length relationship that can be compared to price competition-driven subcontracting. In the middle, there are three types of partnership relationships that include the supply chain collaboration aspect. On the right-hand side, there are two relationships that are deeper than the partnership relationship and were not included in the model by Ali-Yrkkö (2001): joint ventures and vertical integration.

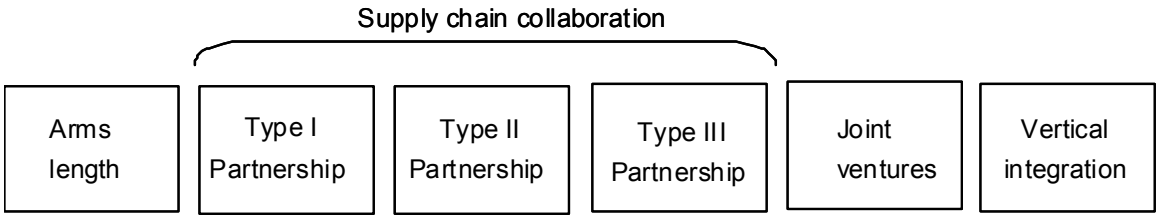

Figure 2-4. Types of relationships (Lambert et al., 1996, p. 28)

According to the framework by Lambert et al. (1996), most of the true partnerships are type I partnerships. Companies consider one another as partners, and coordinate activities and planning together on limited bases. This kind of partnership relationships is usually short-term and does not cover whole company but one of its divisions of a functional area. Long-term oriented relationships are type II partnerships where several divisions or functions of organizations take part in the partnership. Activities in the partnership are coordinated and integrated between the companies. In type III partnership relationships, organizations are integrated at a significant level. Every participating organization sees the others as extensions of itself. The partnership is longer-term than the type II partnership as there is no "end date" for the partnership's existence. This relationship type should be exploited with suppliers that are critical for long-term success. Quite similarly, continuum by Cooper et al. (1997) includes the possible relationship styles from arm's length relationships to extremely close business-to-business relationships. These different relationships inside the continuum include components that determine joint planning, sharing of benefits and burdens, extendedness and trust, systematic operational information exchange, operating controls across firms, and corporate culture bridge-building.

A framework of different supplier relationships based on the strategic importance of buyers' and suppliers' negotiation power was proposed by Tang (1999). This framework classifies relationships into four types as illustrated in Figure 2-5.

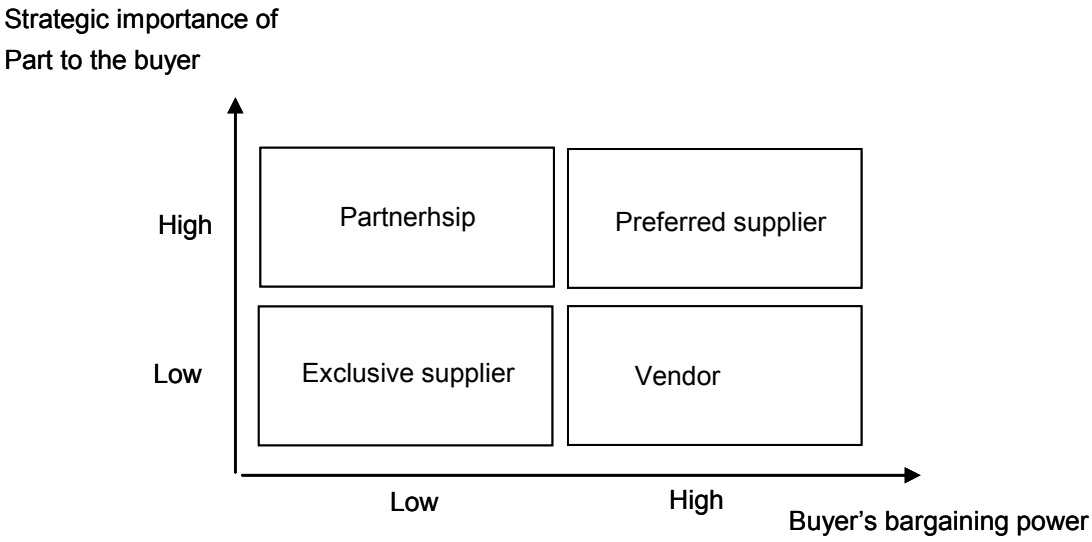

Figure 2-5. Supplier relationship map (Tang, 1999, p. 47)

In the shallowest relationship type, the supplier is defined as a vendor. The vendor delivers parts of a product or service and is able to compete for the unit price only. There are several similar suppliers in the market, and contract times are short. It is easy for the customer to change the supplier. The communication level is low, and there is no interaction between the companies except for the purchase order. In the second relationship type, a preferred supplier provides more complex or unique products and/or services. In this relationship, contract times are longer, and more information is delivered to the supplier. It is not as easy to change the supplier. In the third relationship type, the exclusive supplier provides a unique product or service. Few companies in the market can provide the same product/service; therefore, it is even more difficult to change the supplier. The supplier receives information on the design, sales, and costs. In the partner relationship, the partner provides unique products and services. The supplier commits to revenue- and risk-sharing with the buyer, contract times are long, and the contracts can be incomplete or informal on their nature.

Kampstra et al. (2006) define four arrangements of collaboration practices from the viewpoints of different power distributions between the companies. This model is presented in Figure 2-6. In the type a relationship, called collaboration, there are two equally empowered companies: a major manufacturer and a major retailer. The type b relationship represents the situation where a lead company sets the rules, but the other company is responsible for the coordination. In the type c relationship, the

responsibilities are more uneven, and the lead company controls the activities. In the type d relationship, the lead company sets the rules and outsources the control to other companies.

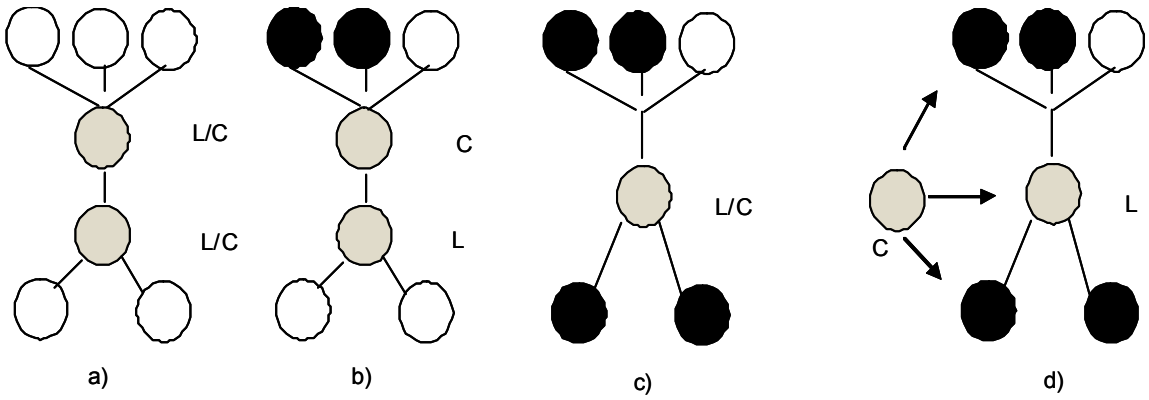

Figure 2-6. Collaboration practices and their limits (Kampstra et al, 1996, p. 319). L=leader, C=coordinator. Empty circles represent organisations not included in collaboration.

In conclusion, depending on what variables are used, there are different ways to present bilateral relationships as a framework. The common thread in all these frameworks is that they include bilateral interorganizational relationships as their building blocks. In the next section, the different bilateral relationships are discussed.

2.2.3. Concepts of bilateral interorganizational relationships

This chapter discusses on the different concepts of bilateral interorganisational relationships that are used in the existing literature. These concept definitions give the background for discussion on risk- and profit –sharing in the later chapters of this study.

The concept of *alliance* appeared in the literature in the late 1980s. Alliance and strategic alliances are often used synonymously in the literature. Because alliances can be thought to always have a strategic intent, it is not easy to differentiate alliances from strategic alliances. Strategic alliances are defined as widely recognized hybrid organizational forms or hybrid arrangements between companies that combine both hierarchical and market elements (Todeva and Knoke, 2005) or as a group that consists of at least two companies that remain legally independent after the alliance is formed, share benefits, have managerial control over the performance of assigned tasks, and make continuing contributions to one or more strategic areas, such as technology or products (Yoshino and Rangan, 1995). The shared ownership for the strategic alliance is identified by Lambert et al. (1996).

Alliances can be defined as operative interfirm arrangements with the goal of achieving the partner's strategic objectives (Das and Teng, 1998). Alliance group can also be defined as a collection of separate companies linked through collaborative agreements (Gomes-Casseres, 1994). According to this definition, the alliance group can consist of a few or many companies. The alliance can constitute of one or several bilateral relationships. The size, pattern of growth, composition, internal competition, and governance structure of this alliance vary. It is emphasized that this arrangement is more than a pure exchange or control: in alliances, the partners collaborate with one another and create new value together (Kanter, 1994; Ohmae, 1989). Alliance can also be defined by its characteristics. According to Dyer and Singh (1998), alliance can be characterized by (1) investments in relation-specific assets, (2) substantial exchange of knowledge, including such an exchange resulting in joint learning, (3) combining of complementary, but scarce, resources or capabilities, and (4) lower transaction costs.

Alliances were not mentioned in concepts of relationship continuums that were analyzed in the last section, but they are themselves divided in many ways in the literature. Based on the degree of commitment and infrastructure linkage between the partnering companies, alliances can be divided into loose affiliates, national buying clubs, co-market agreements, equity participating alliances, partial acquisitions and equity participations, and joint ventures (Clarke-Hill et al., 1998). Similarly, Das and Teng (1998) define joint ventures, minority equity alliances, co-production, and joint researches as different forms of alliances.

The importance of the collective governance in the alliance is often mentioned in the literature. Managerial control is described in the definition of alliance by Yoshino and Rangan (1995). The risk of becoming no more than a haphazard collection of alliances when there is no collective governance is illustrated by Gomes-Casseres (1994). Generally, alliance governance models are classified into two general views: control view and trust view (De Man and Roijakkers, 2008). Alliances can be both short-term project-based and long-term equity-based, and the cooperation between firms have varying degrees of vertical integration and interdependence (Todeva and Knoke, 2005). Alliances are divided into nonequity and equity alliances in the literature (for example, Das and Teng, 1998). Alliances can also be divided according to their lifetime (Day, 1995), as some alliances live only for a short time, while others are forged for a longer period.

The reasons for generating alliances are quite similar to the reasons for generating value nets. Globalization is considered to be the mandate for alliances (Ohmae,1989; Todeva and Knoke, 2005). Companies form alliances in order to manufacture a product and share its operating profits (Lakhal, 2006). Also, industrial factors are responsible for generating alliances (Todeva and Knoke, 2005), while considering technology as an important factor that affects the setting of boundaries and shaping of internal structures in an alliance. The industrial context of alliances exerts strong direct impact on interfirm relationships and affects how the alliance spreads across different subsectors.

According to a different viewpoint expressed by Todeva and Knoke (2005), alliances are driven by indirect positive outcomes from their accumulated intangible assets and corporate social capital, not by expected direct impacts on costs, profits, and other tangible benefits. Alliances lock competitors into cooperative groups where the partners share both risks and benefits resulting from their collective activity. The concept of a supernormal profit that can be jointly generated in an exchange relationship is discussed by Dyer and Singh (1998). This kind of profit is possible to be created only through the joint contributions from the alliance companies. Alliances bring new benefits to the partners in the form of intangible assets and obligate them to make continuing contributions to their partnership (Todeva and Knoke, 2005).

According to Kanter (1994), alliances are like a living system that evolve progressively. Two general principles of the process of the alliance's growth are identified by Gomes-Casseres (1994). First, the alliance needs to attract new members by showing a potential for joint benefits. Second, the antecedent relationships between allies and potential allies can be important in attracting new members.

There are also challenges and drawbacks associated within alliances. Dyer and Singh (1998) emphasize that alliances generate competitive advantages only when they move the relationship away from the attributes of market relationships. The size or business volume of the alliance is not as important as the composition. It must be ensured that the network of companies covers all technologies or markets that are crucial (Gomes-Casseres, 1994). The importance of having the ability to provide incentives for performance is emphasized by Gomes-Casseres (1994). Also, the importance of an effective cooperation inside the alliance and serious commitments by the partners not to take advantage of one another when opportunities arise is crucial for the success of the alliance (Todeva and Knoke, 2005). The importance of realizing the requirements that the alliance may bring to its participants is another factor crucial for the alliance's success (Todeva and Knoke, 2005). The participants may need to reorganize, reduce, or even terminate other business relations because of the alliance.

Joint ventures were already mentioned in the relationship continuums by Lambert et al. (1996) and Todeva and Knoke (2005) in the previous section. A joint venture is formed when "two or more firms create a jointly owned legal organisation that serves a limited purpose for its parents, such as R&D or marketing" (Todeva and Knoke, 2005, p. 214). In the model by Lambert et al. (1996), joint ventures represent the second deepest relationships.

The difference between an alliance and a joint venture is difficult to be ascertained from the literature. For example, the joint venture is assumed to be one form of alliance by Das and Teng (1998). Joint venture is also used as one of the partnership forms by Dutta and Weis (1997). When compared with partnerships, a joint venture has a characteristic of a resource pool as identified by the definition of Kogut (1988). In this definition, the joint venture is seen as a pool of two or more company resources that are included in a legal organization. Alliances and joint ventures were compared by Clarke-

Hill et al. (1998), and it was concluded that joint venture relationships are closer, have a more strategic and competitive achievement focus, contribute more to the product strategy and learning, and build more skills than alliances.

Partnership is also a widely used term in the literature, with many different definitions. Webster's dictionary defines a partnership as "a relationship resembling a legal partnership and usually involving close cooperation between parties having specified and joint rights and responsibilities" (www.webster.com). In a very general scope, the concept of partnership is defined by Gomes-Casseres (1994) simply as relationship between two companies. In some references (e.g. Blomqvist, 2002), the term partnership is used as a synonym for an alliance or interorganizational relationship.

However, partnership is often used for defining relationship involving close and strongly interactive relationships between business organizations (Cooper et al, 1997; Dutta and Weis, 1997). In the concept of the relationship continuum by Ali-Yrkkö (2001), a strategic partnership is considered to be the deepest relationship type. Also, the definition of partnership can be related to a interorganizational entity. For example, the partnership definition by Mentzer et al. (2000) described partnering as an interorganizational entity that is developed between two independent organizations in a vertical relationship within a supply chain that consists of multiple partnerships. The difference between partnership and other cooperation arrangements is described by Edelmann (2001) who asserts that partnerships are long-term contracts in which profits are equally shared in by the partnering organizations. Partnerships have also been defined by Brinkenhoff (2002a) as dynamic relationships among diverse agents, and as having two dimensions, mutuality and identity, that are focal in defining a partnership, which differentiates it from other relationship types. In this definition, the partnership relationship is based on mutually agreed objectives and encompasses the mutual influence, careful balance between synergy, respective autonomy, mutual respect, equal participation in decision-making, mutual accountability, and transparency between the agents. In consonance with the definition by Brinkenhoff (2002a), Lambert et al. (1996) define a partnership as a tailored business relationship based on mutual trust, openness, shared risk, and shared rewards that generate a competitive advantage and improve business performance. By the definition of Lambert et al. (1996), partnership is differentiated from joint venture, strategic alliance, or vertical integration. In the

concept of the relationship continuum by Lambert et al. (1996) that was discussed in the previous section, the joint venture and vertical integration were considered deeper relationships than the partnership. However, it is emphasized, that partnerships can provide similar benefits as those deeper relationships, if well-managed.

The definitions of partnership have different aspects of time, and sharing profits and risks. Long-term collaboration and equal sharing of profits and risks are represented in partnerships in the studies of Ali-Yrkkö (2001) and Edelmann (2001), but many references do not differentiate partnerships from other cooperation arrangements as pointed out by Helander (2004). Profit- and risk-sharing is mentioned as characteristics of partnership relationship by Ellram and Edis (1996), McIvor and McHugh (2000), and Lambert et al. (1996).

A partnership can be defined both as a bilateral relationship between two companies and as a network including several companies (Blomqvist, 2002). Partnership types can be divided on the basis of the features of partnering companies. The concept of an asymmetric partnership can be used in a partnership in which the companies are different in their size and power (Blomqvist, 1999). These asymmetric partnerships have many special features compared with symmetric partnerships. A strategic partnership is distinct from a partnership. In strategic partnerships, products are adjusted and integrated to the system manufacturer's end product in a close cooperation. Mattila (1997) emphasized that in order to be in a strategic partnership relationship, both companies must need each other to develop the end product. The term strategic partnership has been overused in the literature. It is used in situations where the cooperation does not have any strategic importance to the participating organizations (Mattila, 1997); the top priorities in a strategic partnership relationship should be close cooperation, long-term commitment, and mutual trust. Partnership relations have also been categorized on the basis of contracts and the degree to which tacit technological knowledge on technological innovations is likely to be transferred across the company boundaries in the partnership (Dutta and Weis, 1997).

The literature shows also different continuum models for partnership relationships. Brinkenhoff (2002b) examines partnership practices on a relative scale and shows how the gamut of the different definitions of partnership can be illustrated as different

continuum models for different expressions of the partnership relationship. This view is compatible with Cooper et al. (1997), Mentzner et al. (2002), Lambert et al. (1996), and Dutta and Weiss (1997) who represent different continuums of partnership relationships based on different viewpoints. In the continuum of interorganizational relationships, the concept of partnership was divided into three types by Lambert et al. (1996). All three types include the aspect of supply chain collaboration but are differentiated by the integration, contract time, part of the company participating in the relationship, and coordination. Mentzner et al. (2000) suggests a continuum from strategic partnering to operational partnering. The strategic partnering is a long-term relationship for achieving strategic goals of delivering value to customers and profitability to partners. Operational partnering is established on an as-needed basis and is a shorter-term relationship for obtaining parity with competitors. The relationship's place in the continuum depends on the level of orientations of partners and the degree of partnering between the two independent firms.

The fundamental reason for partnerships is synergy. Companies can achieve better results through cooperation than they can individually. As enunciated by Poppendieck and Poppendieck (2007, p.207), "partnerships are not about cost reduction, they are not about risk reduction, not are they about adding capacity". The partnership relations are praised for their benefits in the current business environment. Partnership are seen not only to improve outcomes, but also to bring beneficial synergistic rewards that are bigger than the sum of what individual partners could contribute (Brinkenhoff 2002a).

More cautious statements on the problems in partnership relationships are found in the literature. As Mohr and Spekman (1994, p. 136) have said, when used under the appropriate conditions, partnerships will be successful. This lays emphasis on the importance of the conditions, in which the partnership is entered into. Brinkenhoff (2002a) identifies three problems that are related to the ideal-type partnership. First, the extent to which the definition can be operationalized is unclear. It might also be that it is not universally appropriate, and its reasoning is subjective and value-based.

In this study, the term partnership is used to identify cases of bilateral relationships that include profit-sharing. With profit-sharing, risk-sharing is assumed to be also included in the relationship as a latent variable.

Business relationships denote extremely important long-lasting exchange relations between two firms doing business with each other (Blankenburg Holm et al., 1999). The term *business network relationship* is used to stress that the business relationship exists in the value-creating business network context. Arm's length relationships can be equated with subcontracting relationships. The characteristics of an arm's length market relationship can be listed as nonspecific asset investments, minimal information exchange, separate technological and functional systems within each firm that are characterized by low levels of interdependence and low transactions costs, and minimal investment in governance mechanisms (Dyer and Singh, 1998). Therefore, it is quite easy for companies to change companies with which they have arm's length relationships as they are not rare or difficult to imitate. The two parties cannot generate higher profits than other seller–buyer combinations. In consonance with Dyer and Singh (1998), Lambert et al. (1996) define the arm's length relationship as the shallowest relationship in their concept of the interorganizational relationship continuum.

2.2.4. Decision-making in interorganizational relationships

Decision-making in interorganizational relationships has been studied mostly from the viewpoint of the resource usage efficiency (e.g. Kaihara, 2001). In this study, decision-making is analyzed with regard to collaboration performance. Decision-making received only modest attention in the definitions of interorganizational relationship types in the concepts analyzed in earlier sections. The literature shows that the concept of decision-making is found consistently. For example, the concept of decision-making is missing from the otherwise detailed definitions by Mentzner et al. (2001). On the other hand, decision-making has been considered as an important factor by Lejeune and Yakova (2005) and Giannoccaro and Pontrandolfo (2004).

Decision-making can be classified in many ways in interorganizational relationships. Lejeune and Yakova (2005) discuss two extremes of decision-making in different relationship forms in the supply chain. In myopic decision-making (related to cooperative and coordinated relationships), the entities make their decisions independently and autonomously. They may not take into account the objectives of other entities, or objectives of the supply chain. In dyadic decision-making, entities in the supply chain comply with a set of objectives that further affect the profitability of the supply chain. Lejeune and Yakova (2005) further define two different settings for decision-making: asymmetric or parity-based. In the asymmetric setting, there are several entities that have the greatest power in the decision-making process and impose a set of goals. In the parity-based setting, all entities have an equal power in decision-making. In this setting, the set of goals is commonly agreed upon. Decision-making settings can also be differentiated as centralized and decentralized (Lejeune and Yakova, 2005; Giannoccaro and Pontrandolfo, 2004). In decentralized decision-making, the decision power between the entities is even. In practice, several entities participate in decision-making at different stages. In centralized decision-making, one particular entity or function has the power in the decision-making process. The conditions of decentralized or centralized decision-making are often difficult to verify (Giannoccaro and Pontrandolfo, 2004).

The circumstances leading to decision-making autonomy for all network nodes have been discussed by Villa (2001). The existence of decision-making autonomy is

considered as a prerequisite for performing, serving, and negotiating operations in the supply chain. In the study, three characteristics for decision-making autonomy were defined. First, every entity needs to have a proper performance goal to be reached. Second, every entity needs to have proper knowledge of constraints that must be satisfied for network surveillance. Last, every entity needs to have a proper set of information concerning operations performed by other entities in the network.

The different types of decision-making are discussed in different interorganizational relationships. Decision-making was defined as myopic in communicative and coordinated relationships in the study by Lejeune and Yakova (2005), and partity-based in collaborative relationships. In consonance, shared decision-making has been discussed as a characteristic of collaborative relationships (Simatupang and Sridharan, 2002; Barrat, 2004; Min et al., 2005). All collaboration participants taking part in decision-making has also been attached into the partnership type of relationship (Brinkenhoff, 2002a; Lambert et al., 1996). Research has also proposed that decision-making is one of the key variables characterizing the interdependence level in the supply chain management context (Lejeune and Yakova, 2005).

Sharing of decision-making between the supplier and the manufacturer on their collaboration performance has been studied by Kim and Oh (2005). Their study focuses on the telecommunications industry with a research question on how the structure of the decision-making process affects each supply chain partner's profitability and the relationship's sustainability. Three types of decision-making structures were considered: manufacturer dominated, supplier dominated, and balanced. The study confirmed that balanced decision-making created more value at the system level. Also the study by Simatupang and Sridharan (2008) show a positive linkage between joint decision-making and performance. Their study showed that linkage between performance targets and incentive alignment was found to provide the chain members with appropriate incentives to make decisions that increase the overall value.

The implications of sharing of decision-making on the basis of the need to coordinate decisions lies in the potential increase in collective pay-offs in terms of overall profits and lowered total costs. Since independent decision-making often contributes to the suboptimal performance of decisions that involves independent parties, joint decision-

making provides synergistic benefits to the chain members. Decision synchronization is the process in which the decision rights are assigned to particular chain members within the supply chain, who are then held accountable for the results (Simatupang et al., 2002).

2.3. Performance in the context of this study

Performance is studied within levels of strategic groups, as well as interorganizational relationships in the context of manufacturing of parcelled goods. Performance is also studied in the context of software development projects, but the in the context of software development collaboration, performance has not yet received attention of the researchers. Performance is discussed in this chapter on the basis of value and performance, performance at the levels of strategic groups, companies, interorganizational relationships, and software development projects.

2.3.1. Concept of value and performance

The concept of value has many interpretations depending on which viewpoint it is analyzed. There are studies focusing on the relationship value from viewpoint of supplier, OEM company, and the interorganizational relationship.

The concept of value has been analyzed from the viewpoint of value in supplier–customer relationships by Möller and Törrönen (2003). They propose that the conceptualization of the supplier–customer relationship has three dimensions: the supplier's efficiency function, the effectiveness function, and the network function. These functions are found to be interrelated, but conceptually distinct. The concept of value is analyzed by Ulaga (2003) in terms of OEM companies in which the supplier adds value in a relationship. For this purpose, the value drivers of the relationships are defined as product quality, service support, delivery, supplier know-how, time-to-market, personal interaction, direct product costs (price), and process costs (Ulaga, 2003).

From the supplier's point of view, value can be defined as "the perceived trade-off between multiple benefits and sacrifices gained through a customer relationship by key decision makers in the supplier's organisation" (Walter et al., 2001 p.366). The benefits and sacrifices can be from both the relationship in question and the connected relationships where the focal relationship or other relationships have an impact.

Walter et al. (2001) conceptualize value creation from the supplier's perspective by focusing on German mechanical engineering, electronics, and metal-processing industries. The value creation was divided into direct and indirect functions of customer relationships. Direct functions of customer relationships are activities and resources of the companies (both the supplier and the OEM) that may create value to the supplier without being dependent on other relationships. Direct functions include the profit function (cash), volume function, and safeguard function that all contribute to the profitability of the supplier. Indirect functions have a positive impact on other relationships and include the innovation development function, market function, scout function, and access function. Furthermore, these functions were operationalized to measure the items as follows (Walter et al., 2001, appendix 1):

Profit function

- Margin per product
- Overall profit

Volume function

- Amount of deliveries
- Long-term supply agreements
- Sales volume

Safeguard function

- Possibility of short notice deliveries
- Possibility to sell over-capacities
- Reduction of dependency on other customers

Innovation function

- Joint development of production processes
- Joint concept development of new products
- Adoption of new technologies
- Prototype testing

Market function

- Initiation of contacts with new customers
- Information about potential new customers
- References to potential new customers

Scout function

- Information about the market
- Information about competitors
- Information about relevant third organizations (e.g., further suppliers and customers)

Access function

- Support by handling contacts with governmental agencies
- Initiation of contacts to important persons ("movers and shakers")
- Promotion in influential institutions and committees

The concept of performance will be reviewed in the next section. The definition of value can be paralleled with the performance of the interorganizational relationship when definition of performance is considered broadly (e.g., by Chan and Qi, 2003; Beumon, 1999). In the context of the transactional definition of performance, this equation cannot be made because of the limitations of the performance concept.

2.3.2. Company's business performance

Performance can be generally described in economics as "the proper fulfilment of a contract or obligation according to its terms" (www.webster.com). Business performance of a company has been extensively studied. In a study by Tenhunen and Ukko (2001), it was found that there is no general definition for company's business performance. The researchers have given many different definitions for performance in the literature. Traditionally, business performance is evaluated in terms of productivity and the difference between investments and profits. After 1990, business performance has been understood more broadly. For example, the studies of Tenhunen and Ukko (2001) and Rantanen (2002) define business performance by dividing it into two main

areas: internal and external. In internal business performance, the evaluation is done inside the company, and all internal information is used. Similarly, external business performance is evaluated outside the company, and only public information is used.

The most well-known known measuring system of a company's performance is the balanced scorecard developed by Kaplan and Norton (1992). In the balanced scorecard, performance consists of four different areas: financial situation, customer needs, internal processes, and innovativeness and learning of the organization. Return on sales is also widely used as a measure of company performance in the business level (e.g., Zahra and Covin, 1993).

2.3.3. Performance inside the strategic groups

Performance and profit rates of the companies belonging to strategic groups have been one of the focus areas of research studies. As stated by Porter (1979), strategic groups within an industry fundamentally affect the expected distribution of firms' profit rates. This happens in two ways. First, different strategic groups have different barriers to entry. Second, the presence of multiple strategic groups affects competitive rivalry. The profit rate distribution inside a strategic group is affected by two structural factors. First, the common industry-wide structural trait, structure of buying industries, and generalized buyer purchasing behavior for the product will raise or lower the average profit potential of the industry as a whole. Second, profitability of individual companies will depend on the structure of the industry: for example, the configuration of other strategic groups within the industry.

The performance implications of strategic groups inside and within strategic groups were studied by McNamara et al. (2003). Their study found that performance differences are significantly larger within groups than across the groups. This suggests that some firms develop better resources or competitive positions within groups. According to McNamara et al. (2003), secondary firms within a group outperform core firms within the group and firms that do not belong to any strategic group; the secondary firms may be able to effectively balance the benefits of strategic distinctiveness and institutional pressures for similarity. Companies in different

strategic groups face heterogeneous competitive environments that vary in the profit potential. This generates sustainable performance differences between strategic groups and relatively homogenous performance within groups. Even in the absence of collusion, mobility barriers may exist between groups that lead to performance differences (Caves and Porter, 1977).

However, according to Cool and Decrickx (1993), although the link between the strategic group structure and industry performance has found empirical support, the specific implications of the strategic group membership on firm performance are not clear. On the whole, the group membership is a poor predictor of firm performance (Cool and Decrickx, 1993). Furthermore, theoretical support for a direct relationship between the group structure and the firm profitability is not very strong.

2.3.4. Performance in interorganizational relationships

The existing studies on supply chain performance can be divided into two areas (Bülent, 2008). One area focuses on how to measure supply chain performance, and the other focuses on predictor factors that can explain why some supply chains perform better than others. These two viewpoints of performance measurement research are reviewed in this section, focusing first on measurement and its problems.

Measurement and assessment of interorganizational relationships and their outcomes in general have been identified as a research gap (Brinkenhoff, 2002; Lambert and Pohlen, 2001; Babiak, 2009; Chan and Qi, 2003; Simatupang and Sridharan, 2004). The need for further attention to aspects of the performance or success of interorganizational relationships and different network structures has also been identified (Chan and Qi, 2003; Todeva and Knoke, 2005).

The existing research gap could be explained by the fact that the measurement of performance in general and in the case of interorganizational relationships is difficult. According to Styles (1998), numerous conceptual and methodological problems have been encountered in the definition of performance, and the theoretical aspects of the performance construct have not been adequately developed and tested. Despite the

importance of performance measurement, data availability seems to drive measurement (Styles, 1998). There are problems related to the concept and measurement: whether to use objective outcome indicators (e.g., financial gains, innovations) or subjective indicators as partner satisfaction with collaboration (Todeva and Knoke, 2005).

Difficulties often originate from addressing process and institutional arrangements, and it is often found that the performance management area frequently ignores the limitations these factors (e.g. Brinkenhoff, 2002a). Because the processes and institutional arrangements and their indicators are sometimes difficult to identify and articulate, they are also difficult to quantify and measure (Brinkenhoff, 2002a). As participants have different cost and revenue structures, they also have different individual gains in collaboration and may have different viewpoints for performance measurement (Babiak, 2009; Simatupang and Sridharan, 2005b). In international alliances, difference in gains and success criteria can be applied by firms from different countries and cultures (Todeva and Knoke, 2005).

Research has shown that many existing studies use cost as a primary measure of supply chain performance because it is easiest to implement in quantitative models (Bülent, 2008). However, important trade-offs between different objectives should also be taken into account. It is clear that the performance measures that have limited a scope might be inconsistent with the strategic goals of an organization (Beamon, 1999). This view is shared by Chan and Qi (2003), who emphasize that performance indicators should be focusing on activities and processes or on results.

However, in the current business environment, interorganizational relationships are not just collections of independent and self-centred enterprises that form business relations. Performance measurement should therefore be broader than pure quantification and accounting. Simatupang and Sridharan (2002) showed that inappropriate measures of performance refer to existing traditional measures of individual performance and are therefore irrelevant to the maximization of the supply chain profit. The measurement of interorganizational relationships should be viewed as an evolving process as the benefits of partnerships and relationships are dynamic (Brinkenhoff, 2002a). Dynamic partnerships may include different costs and benefits at different times.

Despite the discussion of problems and difficulties in performance measurement, there is a consensus on the importance of performance measurement in interorganizational relationships. The success of collaborative efforts cannot be assured without properly measuring and monitoring performance (Min et al., 2005). The metrics for success are vital to allow companies to quantify and track their accomplishments, and identify and address emerging problems (Babiak, 2009), to determine rewards for successful collaborative efforts and to identify performance gaps that need to be addressed (Min et al., 2005). One study proposes that the effectiveness of a network should be evaluated at three levels: community, network, and participant (Provan and Milward, 2001). A community is defined as a group of interests that are broader than those at the network level. Network effectiveness is likely based on interactions across all these three levels.

Performance measurement is used to not only control but also motivate the participants. Simatupang and Sridharan (2002) emphasize the importance of common performance measurements as they provide a common language for measuring progress, provide mutual targets, and improve the supply chain operations as a whole. Performance metrics and targets drive the chain members to achieve collaborative objectives and ultimately the supply chain success (Simatupang and Sridharan, 2008). Joint performance measurement is defined by Min et al. (2005) as one component of the conceptual model of supply chain collaboration. In the same vein, it is emphasized that the alliances should have the ability to provide incentives for performance and also the requirement of joint performance measurement (Gomes-Casseres, 1994). It has been also proposed that the needed measures depend on the relationship depth (Mentzner et al., 2000). Performance measures should be broader in strategic partnerships than in operational partnerships, as measures of the total system should be covered in strategic partnerships. In operational partnerships, the measurement could be more focused on the partnership's impact on each firm's performance.

2.3.5. Measurement frameworks for interorganizational performance

Different frameworks have been developed to make the relationship performance measurement easier. Some of these frameworks are reviewed in this section. Also the performance measurement framework for software development projects is also discussed.

Performance "scorecards" are recommended for performance measurement to provide a balanced view of the interorganizational relationship. Babiak (2009) recommends that the factors of relationship sustainability, statuses of the strategic, financial, organizational, and operational objectives, and identification of resources that contribute to sustainable competitive advantages and program success should to be included in the scorecards.

Chan and Qi (2003) propose a performance of activity (POA) measure to identify and employ performance measures and metrics. The study defined the list of seven performance measures from the activity point of view as follows:

- "Cost": financial expenses to carry out one activity
- "Time": the time between the beginning and completion of one activity
- "Capacity": the ability of one specific activity to fulfil a task or perform a required function
- "Capability": the talent or the ability of one activity to be used, treated, or developed for the specific purposes and required functions
- "Productivity": the rate at which the activity improves the value at the cost of resources
- "Utilization": the utilizing rate of the resources to carry out one specific activity
- "Outcome": the results or value added by one specific activity

As stated by Chang and Qi (2003), cost, time, capacity, productivity, and utilization are easy to measure because of their tangible nature. However, the other measures, effectiveness, reliability, availability, and flexibility, are more difficult to measure

because of their intangible nature. The measures that cannot be directly measured need to be transformed to other performance indicators.

One framework for selecting performance measures for supply chain systems was developed in study by Beamon (1999). In this framework, three types of performance are identified as the necessary components of a supply chain performance measurement system: flexibility, resource, and output. As a framework for performance measurement, Min et al. (2005) introduced key performance indicators that are fairly commonly used and cover specific targets on costs, productivity, and savings goals that are modified at least annually.

A cross-industry framework for evaluating and improving enterprise-wide supply chain performance and management was presented by Steward (1997). In this view, performance is measured at four different levels: the top level as process types, the configuration level as process categories, the process element level as decomposing processes, and the implementation level as decomposing process elements.

For the software development project-related performance measurement framework, software project success factors were identified in the study by Goldenson and Hebsleb (1995). These factors of success are the project's ability to meet budget commitments, meet schedule commitments, achieve customer satisfaction, meet the defined goals, and satisfy specified requirements. These success factors were used as factors of performance measures in the study of Lepments (2007). It was found that project managers considered their project to be successful when it met the schedule and budget commitments. The project's ability to achieve customer satisfaction or produce a product that fulfils the requirements was not considered important for overall project success; project managers described the project's success through their personal factors.

2.3.6. Factors affecting interorganizational relationship performance

As discussed earlier, the second focus area of interorganizational relationships performance research is the factors that affect performance. A higher degree of collaboration practices has been found to be one of the factors affecting improved

performance in interorganizational relationships (Simatupang and Sridharan, 2005b). The study showed collaboration practices as information sharing, decision synchronization, and incentive alignment as the highest coefficients to the performance, as well as the combination of decision synchronization and incentive alignment.

Research has shown trust to be important factor in interorganizational relationship performance (see e.g. Mohr and Spekman, 1994; Das and Teng 1998; Blomqvist, 2002). However, research has also shown that the collaboration effects of financial performance would be stronger under conditions of low trust than under conditions of high trust (Corsten and Felde, 2005). It was further speculated that the safeguarding effect of collaboration could be stronger in low-trust situations where the risks of opportunism are high and joint actions ensure harmonized processes and capabilities. On the other hand, in conditions of high trust, the incentives appear aligned and the protective effect of collaboration seems to be substantially lower. Alternative explanations for the result could be that in the collaborative relationship, high trust can be detrimental because too much trust can be "too close to comfort" and lead to vulnerability toward a supplier, and in the context of low dependence, collaboration could have stronger effect on innovation and financial performance (Corsten and Felde, 2005). Research has also shown that the transfer of tacit knowledge between the companies in alliance relationship is highly related to the perceptions of the partners' trustworthiness and both have a significant effect on alliance success (Becerra et al, 2008).

Also the different interorganizational relationship types can be compared to find factors that affect performance in an interorganizational relationship. There seems to be a common conception that partnerships would produce only added value beyond other relationship types (referred e.g. by Brinkenhoff, 2002a; Shah and Singh., 2001). Mohr and Spekman (1994) measured the success of partnership relationships by using two indicators: an objective indicator (e.g., sales volume flowing between dyadic partners) and an affective measure (e.g. satisfaction of one party with the other). The study showed that the primary characteristics of partnership success are commitment, coordination, trust, communication quality, participation, and the conflict resolution technique for joint problem solving. The impact of decision-making sharing between the supplier and the manufacturer on their collaboration performance was studied by

Kim and Oh (2005), and the study confirmed that balanced decision-making creates more value at the system level.

Risk- and profit-sharing are often related to the concept of partnership relationship, as it was described in the concept analysis of bilateral interorganizational relationships. Risk- and profit-sharing are recognized as a factors that increase the relationship performance (e.g. Lakhal, 2006; Cachon and Laviere, 2005; Lejeune and Yakova, 2005; Wang et al., 2004; Whang, 1986; Cachon and Laviere, 2005; Foros et al., 2009). However, these studies are made in the context of parcelled goods manufacturing. In this study, profit- and risk-sharing are the chosen factors whose implications on software development collaboration performance are studied. In the following section, the existing research of risk- and profit-sharing are analyzed in more detail.

2.4. Risk-sharing in interorganizational relationships

In the following sections, the concepts of risk- and profit-sharing in the context of interorganizational relationships are discussed. These two concepts can be viewed as latent with each other. It is said that profit-sharing is a supply chain contract that enables supply chain partners to share the risks (Tsay, 1999). These two concepts cannot be easily isolated in practice, but these two aspects are analyzed for the concept analysis.

2.4.1. Concept of risk

In general, risk is determined as a possibility of loss or injury (www.webster.com). In the literature, there are different interpretations as to whether only the negative outcomes are determined as risks. There are also different views on whether the term includes a probability of a loss or injury.

In the literature, risk is usually considered to be the possibility that there is a negative outcome (Charette, 1989; Boehm, 1991; Fishburn, 1984), or at least one of the outcomes is determined to be negative (Östring, 2003). Some references include possibilities of both negative and positive outcomes. The uncertainty of the positive

outcome is included in the strategic management literature's decision theory (Ruefli and Collins, 1999) and in research related to collaboration (e.g., Edelmann, 2001).

The probability of the outcome is included in the risk determination by Charette (1989), and risk is determined as the potential for an unwanted issue to be encountered. The definition by Charette (1989) found that both the extent and the occurrence of a loss can be measured, but they are not always independent factors. In consonance with this broad definition of risk, Kontio (2001) determined risk as a possibility of loss, the loss itself, or an action that is associated with that possibility.

Some references do not use the term "risk" alone. For example, article by Boehm (1991) introduces the term *risk exposure*, which is the multiplication of the probability of an unsatisfactory outcome and loss to the parties affected if the outcome is unsatisfactory. This concept is broader than the earlier risk determinations, but it has received criticism. Barki et al. (1993) point out that there are many problems when defining the risk exposure because it is difficult to define the probability of some instances, especially in the R&D environment. Boehm's concept has no absolute risk. This concept also points out that the risk is dependent but it depends on who is measuring it.

There are problems in using the concept of risk. Ruefli and Collins (1999) found that for strategic management research, the concept of risk relies on the borrowed measures and techniques from disciplines like financial economics and statistical decision theories. According to their study, the strategic research has not incorporated the concepts of risk used by managers to assess and manage the risks of their decisions. Therefore, the measures and conceptualisztions of risk do not fit perfectly into the key concerns of strategic management researchers. There is a problem of defining risk too narrowly and measuring it too simply by typically relying on secondary data sources to estimate single measures of risk (e.g., variance in accounting returns).

Risk itself is a measurable concept. In addition to verbal determinations of risk, there are different mathematical definitions of risk in the literature (for example, Fishburn, 1984; Jian and Dyer, 1996). In this study, the magnitude of risk itself is not measured, but risk is measured by managerial experiences of risks. This research concentrates on the risks involved in software development function during a collaboration between two

companies. Next, the risks in software development are described. Special characteristics of software development risks typically arise from the features of software itself, which were discussed earlier. Risk in software development includes the elements from the general definition of the risk concept. However, risk can be evaluated and specified in more detail and more variations to the definitions can be proposed.

Software risk can be defined as an event that endangers the success of the software development process (Boehm, 1991). It can be a wrong software operation, rework of programming, difficulties in work, delay, or uncertainty. Boehm (1991) showed that there is no universally usable risk classification and that it is not possible to determine all the possible risks. Other definitions of software development risks define risk as an event, state, or action that endangers the achievement of the targeted aspiration level in software development (Ropponen, 1999) or as the multiplication of the project uncertainty and the magnitude of potential loss (Barki et al., 1993). The definition by Barki et al. (1993) is quite different than Boehm's (1991) and it does not refer to probability but to uncertainty. Also, the volume of unsatisfactory outcomes differs from many (Boehm, 1991) to only one (Barki et al., 1993).

For this concept analysis on software development risks, different risk elements were collected from the literature and further grouped into four clusters in order to make the representation of software development risks more structured. These four clusters are product-related risks, project-related risks, organization-related risks, and process model–related risks.

Product-related risks are risks related to the ready product. These risks include developing a wrong user interface (Boehm, 1991), developing a wrong functionality (Boehm, 1991), not meeting requirements (Chittister and Haimes, 1993; Boehm, 1989; Barki, et al, 1993), performance problems (Boehm, 1991), and technical problems in the product functionality (Charette, 1989), and gold-plating (Boehm, 1991). A ready product also has a support risk, the risk of failing to maintain or enhance a system with planned resources. These risks are often encountered because of the changing or unclear requirements (Williams et al., 2006), product complexity, and inability to understand a ready software product that drive the software development project into a wrong direction.

Project-related risks include cost overruns and schedule slippages (Chittister and Haimes, 1993; Boehm, 1989; Barki et al., 1993; Ropponen, 1999; Charette, 1989). These are related to subcontracting management also, while the success in estimating personnel needs is connected to proper subcontracting management (Ropponen, 1999). One factor for cost overruns is rework. It is stated that rework that is caused by requirement, design, and code errors consumes typically 40–50% of the total cost in software development (Boehm, 1989),. All the risks in this category, including the rework, are encountered because of the unrealistic plans for schedules and budgets, and changing requirements that were discussed earlier. One issue that makes contracting between partners difficult is the lack of precise foreknowledge of the task (Humphrey, 1990).

Since software development is very human-dependent, the organization-related risks form a remarkable risk. They are predefined as risks that are related to the human resources of the software development project. Resources are both internal and external. Because of the importance of the human intellectual resources, they are determined as separate entities. Risks related to only external resources are subcontracting risks, contract cancellations, contract problems, and litigations (Charette, 1989). Other organization-related risks are the lack of competent personnel (Boehm, 1991; Ropponen, 1999; Charette, 1989) and wrong resource usage (Ropponen, 1999). Personnel management risks (Ropponen, 1999) and competition inside teams (DeMarco, 1995) also result in risk when problems in trust and cooperation or values arise (DeMarco, 1995). The contractors' capability of performing software engineering as one of the risks in software engineering is considered by Humphrey and Sweet (1987). Barriers that prevent natural interactions between software developers can also be seen causing risks (DeMarco and Lister, 1999). Collaboration always brings this kind of barriers in the form of the geographical distribution or barriers between companies. Subcontracting risks were identified as one of the six software risk factors by Ropponen (1999).

Some software development process model-related risks have also been discussed in literature. For example, waterfall model-related risks include overpromising software capabilities in contracts before they are really understood (Boehm, 1991). It has been also recognized that when it is easy to bring new functionalities into the product during

the development phase in the evolutional development process, these additions may end up as disasters, especially in complex and large projects (Boehm, 1991). Agile software development methods are developed to respond these challenges by bringing lighter weight along with faster and nimbler software development processes (Abrahamson et al., 2002).

Collaboration-related risks have been represented in many different ways in the literature. There are different frameworks, groupings, and lists of risks. Collaboration can be seen as a way to decrease risks of the OEM. It also changes the nature of risks for both companies and brings new kind of risks for them.

In the definition of supply chain risks, a node or link in the network is defined as the location where risk events might arise (Cheng and Kam, 2008). A recurring theme in literature is the reasons for special risks in collaboration. According to the study by Faisal et al. (2006b), there are many sources of supply chain risks, as different links of a supply chain are exposed to different types of risks. The complex mix of different collaborator companies adds complexity to the risk profiles of inter-related components inside business networks. For a given network collaboration, several structures of network relationships are possible, each of which carries distinctive risk implications). The risk is perceived to be distributed differentially among the companies, depending on their structural relationships, their functional contribution to the collaboration, and their ability to discharge these functions (Cheng and Kam, 2008). It cannot be determined what kinds of risks the networked companies will face, and there are multiple risks whose direction, probability, and impact vary (Hallikas, 2003).

The sources of supply chain risks can, for example, be divided into environmental, organizational, and supply chain-related variables (Faisal et al., 2006a). They can also be categorized as relational and performance risks (Das and Teng, 1999). The relational risks are related to the relations with another company. Performance risks are due to the issues other than the relationship between collaborative companies and can be caused by internal or external factors, such as markets or environments. Normally, when companies are collaborating, they are reducing performance risks and sharing relational risks.

In view of the complexity in network configuration, a structured approach to developing a risk analysis framework is seen appropriate to capture the key properties of multifirm collaboration, such as delegated decision-making, interdependency, and interactions (Cheng and Kam, 2008). The study presented a framework to provide a structured approach for identifying and assessing risk dynamics and their differential impacts on different levels of supply networks. There are also other studies proposing different frameworks for collaboration risks. Londsdale and Cox (1998) grouped risks as the loss of core activities, being leveraged by suppliers, the loss of strategic flexibility, interruptions to supply, receiving poor supplies, a fall in employees' morale, a loss of internal coherence, confidentiality leaks, and the loss of intellectual property rights. Edelmann (2001) divided the collaboration risks into five groups: spillovers and appropriateness hold up, inefficiency, timing, and communication risks. The communication risks stem from various communication problems: lack of communication, incorrect communication, unclear communication, or too slow communication. In addition, Hallikas (2003) show that in situations where information is coming from the main contractor the suppliers can consider some information to be unreliable because of the contractor's own interests and targets. These all problems with the communication harm decision-making and planning possibilities, bring uncertainty, and cause duplicate work, and companies lose inputs.

The importance of communication-related risks is emphasized also in other studies. Lack of cooperation and the opportunistic behavior of partners cause the relatively high rate of failure of alliances (Das and Teng, 1998). Revealing confidential company information is seen a risk especially in close strategic partnership relationships (Mattila, 1997). Also both incoming and outgoing spillovers are risks. Incoming information can be false or misunderstood, and outgoing information can take the organization's competence or secrets to other parties. Spillovers cannot be totally avoided since there are also spillovers between the partners that bring efficiency by decreasing duplicate work (Edelmann, 2001). The transfer of tacit ad explicit knowledge has very different trust and risk profiles in the interorganizational relationships. Becerra et al. (2008) found that transfer of explicit knowledge was closely associated with the willingness to take risks and transfer of tacit knowledge was highly related to the perceptions of the partners' trustworthiness.

Since the relationship between collaborative companies evolves and changes over time, research also shows typical risks for different relationship phases. Das and Teng (1999) divided the alliance relationship into four phases—selecting alliance partners, structuring the alliance, operating the alliance, and evaluation of the alliance performance—and analyzed the relationship-related risks in accordance with these phases. Risks in the first phase, selecting alliance partners, involve finding a resource fit and a strategic fit between partnering firms. This was found very difficult since the objectives of the partnering firms may change over time. In the second phase, when the alliance is structured, the risk is on keeping up the good balance of flexibility and structural rigidity. These are often in conflict. In the third phase, the alliance is operating, and the risk is on managing the cooperation and competition of the companies inside the alliance. The last phase, alliance performance evaluation, is difficult since there are no generally accepted criteria to measure alliance performance. There is a risk to overemphasize performance. The alliances often want results too quickly, even when the alliances are involved in time-consuming projects because learning to work together takes time.

The above-mentioned and grouped risks are risks for both the OEM and the supplier. Only the risks listed by Londsdale and Cox (1998) are for the OEM only. Risks for the supplier are presented in Hallikas (2003) and Quinn and Hilmer (1994). From the supplier point of view, biggest financial risks include cost control, investment cost growth, rapid cycle of new investments, increased production costs, rise in labor costs, and pricing (Hallikas, 2003). Price negotiations and one-sided cost openness are also considered to be substantial financial risks for suppliers. The risks of being dependent on the other company and vulnerable were shown as supplier's risk by Quinn and Hilmer (1994).

However, research has shown that the OEM and supplier companies perceive the risks in the relationship very similarly. The study by Hallikas (2003) concluded that this results from the relatively long-term cooperation between the companies that experience and understand the risk factors as part of the daily business. However, it was seen that the suppliers place more stress on the operational level and short-term activities in their risk identification. Some supplier companies saw the risk of being dependent on only a few customers as a selected strategy rather than a real threat, while OEMs saw the

industry and customer specificity of suppliers as a factor that makes them vulnerable in changing business conditions.

Summarizing the earlier analysis of the risks in software development collaboration, in a set-up of two collaborative companies, the risks can be grouped as in Figure 2-7. First, when the companies are operating separately before the collaboration begins, both companies have risks of their own. These risks are illustrated as [a] and [b] in the figure. When the two companies start collaborating, the collaboration brings new collaboration-specific risks for both companies. These risks are illustrated as [c]. In addition to these risks, the collaboration changes the risks of operation of both companies, [a] and [b], at least to some extent. Some of these are transferred to the other company because of the interorganizational relationship, described in the figure as risks [d] and [e]. This study focuses on the shared risks [d] and [e], and how the risks of software development and their consequences related to the product development and collaboration are shared between the companies.

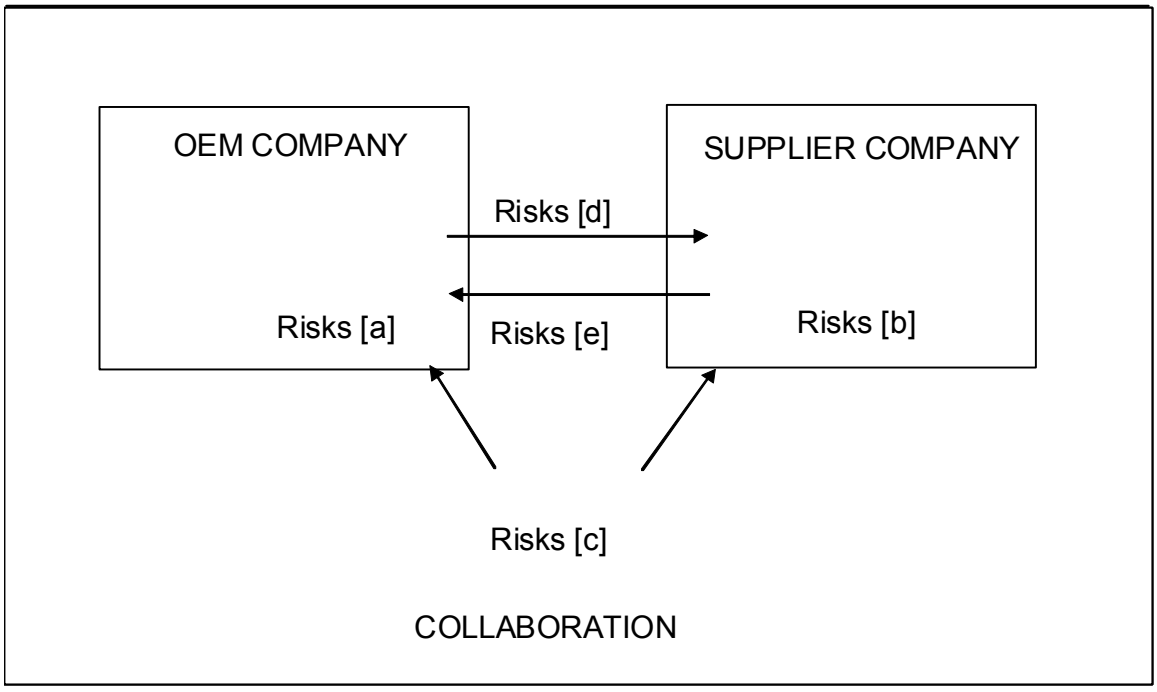

Figure 2-7. Risks in the concept of this study

2.4.2. Concept of risk-sharing in collaboration

Risk-sharing between collaborative companies is discussed in the literature as a cost of the benefits that the collaboration brings to the companies. The amount of shared risks and shared benefits from the collaboration differs according to collaboration modes between the companies. Studies have been done in the context of parcelled goods production where risks are related mostly to inventory levels and unit costs (e.g., Lockamy and Smith, 2000; Tang, 2006). This section concentrates on how the concept of risk-sharing is considered in different interorganizational relationships in the existing literature.

The suppliers always share some of the business risks with the company they collaborate with (Camarinha-Matos et al., 2009)). This decreases the business risks of the customer company but also brings new risks that the company needs to manage with the counterparts. The suppliers are an integrated part of the company's business risk. The company is more dependent on its suppliers when the relationships are strategic in nature, the contract times are long, and the cooperation is deeper. Choosing the right suppliers is even more important than before. In the past, the quality of the produced components was the most important criteria when choosing a supplier. Now, the internal processes and process management, business, and financing of the supplier are also important factors when choosing a supplier. A greater effort is therefore needed for supplier management in strategic relationships (Östring, 2003).

Risk-sharing between the companies has been discussed in the definitions of interorganizational relationships in earlier sections. Risk-sharing is typically associated with collaborative relationships (Camarinha-Matos et al. 2009; Simatupang and Sridharan, 2002; Barrat, 2004; Min et al. 2005). In the same vein, risk-sharing has been defined as a characteristic of partnership type of relationship by Tang (1999), Lambert et al. (1996), Ali-Yrkkö (2001), Edelmann (2001) and Cooper et al. (1997). Lambert et al. (1996) proposed risk-sharing as a factor by which the companies generate the competitive advantage in the partnership. Mentzer et al. (2001) considered risk-sharing as one of the key components in supply chain management.

Many factors determine the amount of shared risks. The risks are shared differently in discrete and relational transactions (Dwyer et al., 1987). In discrete transactions, there is

a sharp division of risks into parts that are allocated to each company. In relational transactions, there is some sharing of risks, and the companies make adjustments to both shared and own parts of risks. Willingness to take and carry risks depends on companies, their cooperation models, targets, and environment. As company owners find more rewards, they are ready to take more risks (Östring, 2003). Kawasaki and McMillan (1987) show, for example, that when the supplier is more risk-averse than the buyer, the supplier would be willing to accept a lower price if the buyer carries part of the risk of production cost increases. Consequently, when the supplier is not fully responsible for the costs, its incentives are weaker for production cost decreasing. Latent networks and competitive forces increase the complexity of potential risk factors. The failure of the supplier in this set-up could lead to the failure of a sub-network. However, the complexity of the network also offers many options for risk recovery (Cheng and Kam, 2008). The literature also records studies that have considered doubts about how the risks and rewards can actually be shared in practice. Small suppliers are not able to share risks with the OEM to the extent that would be needed for proper profit-sharing (Helander, 2004).

2.4.3. Models for risk-sharing in interorganizational relationships

To assess the risks in supply chains and to identify direct risks to operations, companies need to identify the potential causes or sources of risks in every significant link along the supply chain (Christopher et al., 2002). Risk measurement is recommended to be done at three different levels: network level, subnetwork level, and individual node and link level (Cheng and Kam, 2008). At the level of individual node and link, it is necessary to deal with propagating impacts and implement risk recovery procedures to contain and mitigate impacts. This study concentrates on risk-sharing between two companies in software development collaboration at the individual node and link levels. Previous studies have considered how the risks in collaboration should be measured, identified the risk-sharing variables between companies, and defined the circumstances around these variables.

First, the risk-sharing variable defined by Jarillo and Ricart (1987) is discussed. When studying the problem of finding the suitable trade-off in sharing risks that is best for the relationship, the variable α was determined to represent the share of risk that is taken up by the principal company. This variable α have the following two alternatives:

> α=0: In this situation, the subcontractor bears all the risk. The agreement is a purely fixed-price contract. This is not a real collaborative relationship as it could be buying something at a given fixed price with no further involvement between the companies.
>
> α=1: In this situation, the principal company bears all the risk, and the agreement is a cost-plus contract. The problem in this situation is that there are no incentives for the subcontractor to be efficient in the cooperation.

Based on these two situations, Jarillo and Ricart (1987) claim that the network is efficient when $0<\alpha<1$. The network is efficient only when it offers the companies more than what they demand.

A second risk-sharing variable was defined by Kawasaki and McMillan (1987). This *sharing parameter* α is used to determine how cost overruns and underruns are shared between the principal company and the subcontractor. The sharing parameter describes sharing the risk of cost changes, rather than sharing actual profits. The following alternatives are given for this sharing parameter α:

> If α=0, a contract is made for a fixed price, and the subcontractor carries the whole risk of cost changes. According to Kawasaki and McMillan (1987), this is the first-best amount of cost-controlling effort from the subcontractor. In this case, the subcontractor receives all of the benefits and incurs all of the costs.
>
> If α=1, the contract is cost plus, and the principal company carries the whole risk of cost changes.
>
> When $0<\alpha<1$, the risk is shared between the two companies, and the contract is an incentive contract.

The model by Kawasaki and McMillan (1987) states that as α becomes larger, the subcontractor becomes less responsible for costs and less motivated to undertake any cost-reduction activities. On the other hand, when the contract does not have a fixed

price (α>0), the shifts some of the risks of cost changes into the principal and reduces the variance of the subcontractor's profits.

For the sharing parameter, the study by Kawasaki and McMillan (1987) presents the following formula:

$$\alpha = \frac{\lambda\sigma^2}{\delta + \lambda\sigma^2}, \text{ where the chosen level of } \alpha \text{ satisfies } 0 \le \alpha \le 1$$

α decreases the moral hazard δ, increases the variance of cost disturbance σ^2, and increases the risk-aversion coefficient λ.

2.5. Profit-sharing in interorganizational relationships

The second factor, which impacts the collaboration performance, analyzed in this research is profit-sharing in interorganizational relationships. Profit-sharing, also described in the literature as reward sharing, is studied widely in the context of parcelled goods, especially regarding unit prices in the case of changing demand (e.g., Giannoccaro and Portrandolfo, 2004; Lakhal, 2006; Chauhan and Proth, 2005; Esmaeli et al., 2009; Bichescu and Fry, 2009). In this section, the concept of profit and profit-sharing are considered.

2.5.1. Concept of profit

Generally, profit is usually defined as the business profit of the company. For example, the Webster's dictionary (www.webster.com) defines profit as (1**)** a valuable return, (2) the excess of returns over expenditure in a transaction or series of transactions, especially the excess of the selling price of goods over their cost, (3) net income usually for a given period of time, (4) the ratio of profit for a given year to the amount of capital invested or to the value of sales, and (5) the compensation accruing to entrepreneurs for the assumption of risk in business enterprise as distinguished from wages or rent. Generally, there are two ways how the business entities can increase profit in two ways: by increasing sales or by reducing costs (Chan and Qi, 2003).

To be more precise, profit can be defined narrowly as the return on equity capital. In general, profit includes the interest costs on borrowed capital (Lovell, 1978). Profit is calculated within a specified time span. Profit can further be defined as "the excess of benefits over costs of productive activities in each period when all relevant costs are measured in terms of their shadow prices or opportunity costs" (Scapens, 1978, p. 448). Profit can be measured in multiple levels; at the company level as, for example in accounting, or the level of one product or module (Bowon and Oh, 2005).

The character, use, and source of profit are not the same throughout the economy, as outlined already by Bernstein (1953). Therefore, it should be clearly stated whose profit the discussion concentrates on, how profit is measured, that is, as an amount of currency or as a rate, and what elements profit consists of. Lovell (1978) presented 14 different alternatives for measuring profit. These are divided into four concepts: profits, profits plus interests, profits after the corporate profits tax, and profits plus interests after the corporate profits tax. This all illustrates the wide variety how the concept of profit can be defined.

2.5.2. Concept of profit-sharing in collaboration

The concept of profit-sharing between the companies has been discussed in the definitions of interorganizational relationships in earlier chapters. The terminology related to profit-sharing is diverse. Research studies term incentive alignment (Simatupang and Sridharan, 2008), profit-sharing (Lakhal, 2006; Edelmann, 2001; Ali-Yrkkö, 2001), reward sharing (Lambert et al., 1996), revenue sharing (Tang, 1999), and benefit sharing (Dyer and Singh, 1998) to describe the sharing of the positive outcome of the interorganizational relationship. In the continuation, these all terms are used as synonyms in concept analysis.

The concept of profit-sharing is discussed quite much in relation to the risk-sharing. Profit-sharing has been attached to the definition of collaboration (Camarinha-Matos et al.,2009; Simatupang and Sridharan, 2008; Min et al., 2005; Barratt, 2004). Also, it is included in many partnership definitions (e.g. Chauhan and Proth, 2005; Edelmann, 2001; Ali-Yrkkö, 2001; Tang, 1999; Lambert et al., 1996). In addition, the aspect of profit-sharing is also included in many definitions of alliances. For example, Dyer and

Singh, 1998; Lakhal, 2006; Yoshino and Rangan, 1995 include profit sharing as a characteristic of alliance. Profit sharing is considered as one of the key components of supply chain management by Mentzer et al. (2001).

In related to the profit-sharing concept, previous studies have also discussed a win–win situation that should be built in the interorganizational relationships for success. A win–win condition occurs when participants have higher profits with the participants than without them (Giannoccaro and Pontrandolfo, 2004). This kind of win–win situations can be difficult to achieve, especially with complex relationships (Assman and Teade, 2004). When there are multiple levels of subcontracting, it is hard to see what does the term "win" means for each party.

In the literature, there is a broad understanding of the importance of profit-sharing in interorganizational relationships and further in supply chains. Mentzner et al. (2001) composed a list of supply chain management activities and management practices that the companies need to implement, which included "mutually sharing risks and rewards" as one activity. It has also been stated that supply chain management requires long-term orientation, expectations relationship to be extending with sharing of rewards balanced over time (Cooper and Ellram, 1993) also. An equitable and efficient formula needs to be defined for the distribution of profits generated by the network (Lakhal, 2006).

The importance of the equitability and fairness of profit sharing has been emphasized. The studies by Das and Teng (1998) and Lee (2004) asserted that the profit distribution between partners must be kept on an equitable basis. The importance of collaboration's mutual value offering to the partners is stressed by Day (1995) and Camarinha-Matos et al. (2009). The fairness of sharing mechanisms was discussed by Jarillo (1988), Hallikas (2003), Narayanan and Raman (2004), and Giannoccaro and Pontrandolfo (2004).

The positive implications of profit-sharing are seen broadly in the literature. The incentive system defined by De Man and Roijakkers (2008) are used as a control mechanism to motivate managers and personnel to contribute to the alliance. Incentives can be the defining factor for how decision-makers are to be rewarded or penalized for the decisions they make (Simatupang et al., 2002). Profit-sharing is generally seen as a way to eliminate the typical problem of every company behaving to maximize its own

profits (Narayanan and Raman , 2004; Simatupang and Sridharan, 2002, 2005a, 2008). Profit-sharing makes partners to behave in ways that are best for everybody. According to the statements in the study by Narayanan and Raman (2004), a supply chain works well when its companies' incentives are aligned so that the risks, costs, and rewards of doing business are distributed fairly across the network. The challenge is to make all the companies in the supply network play the game so that everybody wins. The only way to do that is by aligning incentives. Incentive alignment gives the members motivation to act in a manner consistent with their mutual strategic objectives that include making decisions that are optimal for the overall supply chain and revealing truthful private information (Simatupang and Sridharan, 2002, 2005a, 2008). An effective incentive scheme means that the chain members are self-enforcing to align their individual decisions with the mutual objective of improving total profits (Simatupang and Sridharan, 2002). Profit-sharing is also seen as a way to manage risks (Das and Teng, 1998) and bring mutual commitment (Dwyer et al., 1987). The importance of commitment in software development has been stressed upon (Poppendieck and Poppendieck, 2007).

Research has shown that the profit-sharing has positive implication on performance in interorganizational relationships (Wang et al, 2004; Whang, 1986; Cachon and Laviere, 2005; Foros et al., 2009). In the study by Wang et al. (2994), it was found out that both the channel performance and the performance of the individual firms depended critically on the retailer's share on channel cost for merchandises sold via Internet marketplace. On the basis of this finding, they developed a model that shows that if the retailer's profit share is below 50%, the channel cannot achieve its best performance because individual firms optimize their own profits in the cost of the total channel performance. Similarly in the study by Foros et al (2009), it was found out that for commodities distributed by mobile networks, the supply chain's downstream firms maximize the aggregate channel profit when having the right incentives in place.

The creation of effective incentive alignment has three important aspects (Simatupang and Shridradan, 2005): the level at which the incentive will be paid, how the incentive will be linked to overall performance, and how the incentive will be paid. The effectiveness of incentive alignment can be evaluated based on compensation fairness and self-enforcement.

A lean production system can be considered as the best practice of operational management of a company. Supply chain management is considered as a major strength of the lean production system (Womack et al., 1990; Morgan and Liker, 2006). Womack et al. (1990) stressed the importance of profit-sharing in supply chain management in the lean production system. In the lean production system, agreements to share profits between the OEM and the supplier give the supplier an incentive to improve the production process.

Despite all these benefits of profit sharing activities, there are also drawbacks related to profit-sharing found in the literature. It is considered that management devotes considerable energy and time in negotiating equitable arrangements to share the rewards of collaborative agreements (Faisal et al., 2006b). In the study by Helander (2004), it was also doubted that in turbulent industries (such as the software development industry), the companies do not want to become deeply engaged with any partner.

2.5.3. Models for profit-sharing in interorganizational relationships

Research shows different model frameworks for profit-sharing, which are reviewed in this section. The study by Karjalainen et al. (2004) determined three categories of models of sharing profit and risk between suppliers and customers. These models are presented in Table 2-1.

Table 2-1. Categories of sharing profit and risk between suppliers and customers according to Karjalainen et al. (2004)

Category	**Profit and risk sharing mechanism**
Category A	A1 Fixed price
	A2 Fixed unit price
	A3 Costs plus fixed fees
Category B	B1 Expectation of extra reward
	B2 Extra reward on the supplier's performance
	B3 Extra reward on the customer's sales
	B4 Extra reward on the customer's profit
Category C	C1 Supplier's entire profit at risk
	C2 Profits and losses shared
	C3 Supplier's compensation embedded in the product price

Category A includes cost-plus pricing methods. In these methods, suppliers' costs are covered at an agreed level. These methods do not give much motivation for suppliers to improve their performance or to be innovative. In the case of the fixed unit price, when the supplier is more effective than planned and the units are working hours, the supplier gets the maximum profit if it uses all the planned hours. In this case, is the supplier is motivated to keep the performance as planned, but not improve it.

In category B, suppliers can have more profit if their performance level is better than the planned level. At the same time, suppliers' risks increase in this category. The methods in category C are risk-reward compensation. These methods require an agreement on how profit sharing is done and measured.

Another model of profit-sharing is presented in the study by Ali-Yrkkö (2001). The study examined risk- and profit-sharing in the relationships in the Finnish communication technology (ICT) industry from the supplier's point of view. Different risk- and profit-sharing arrangements among the suppliers can be defined by four different groups, A, B, C, and D, as illustrated in Figure 2-8.

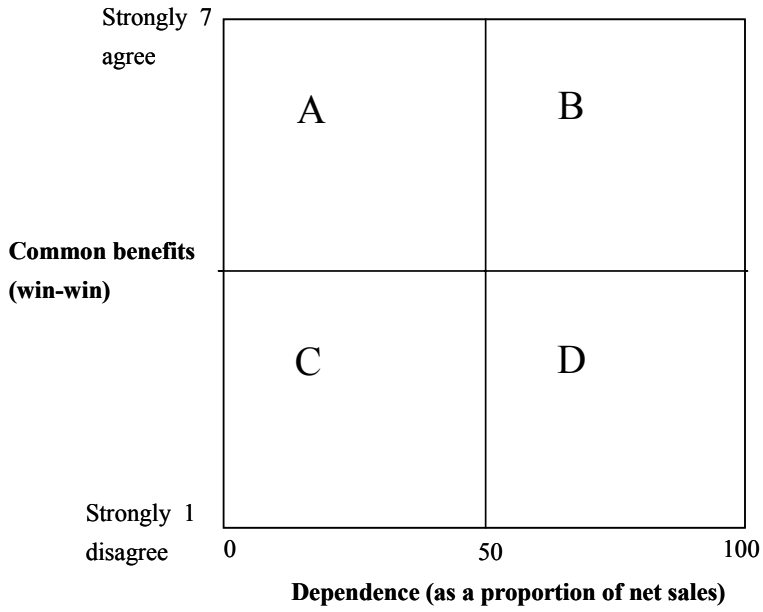

Figure 2-8. Mutual benefits and dependence (Ali-Yrkkö, 2001, p.75)

The horizontal axis shows the risk, which is measured as the supplier's dependence on the key customer relationship as proportion of net sales in percent. The vertical axis

shows the common benefits (also called as win–win), which is measured by variable describing the win–win aspect of relationship as suppliers estimation in Likert scale 1–7. According to Ali-Yrkkö (2001), when the value of vertical axis is above 4, the supplier perceives the relationship as a true partnership with reciprocal benefits. Consequently, if the value in vertical axis is below 4, the company feels the relationship is not a partnership type and there is no sharing of profits or goals between the companies.

In type A, the relationship gives benefits to both partners, and the supplier is not too dependent on the customer. In the type B relationship, benefits are also mutual, but the supplier is highly dependent on the customer. This is a high-risk strategy, which Ali-Yrkkö considered to be a good strategy only for young companies or companies that want to grow rapidly. In the long run, the challenge for these companies is to enlarge their customer base. Ali-Yrkkö's study characterized type C relationships as traditional business relationships without true partnerships. Buyer and supplier companies both pursue their own interests and do not share their goals or profits. The type D relationship includes high risks with low benefits and is not profitable for the supplier. The supplier should either decrease the dependency or change the relationships to get more benefits. It is interesting to note that most of the companies in Ali-Yrkkö's study felt that their relationships with key customers were the win–win type, most of the relationships were type A, and the second largest group was type B. Key customer relationship of software companies was more win–win than that of the electronic manufacturing service companies.

2.6. Hypotheses development

The hypotheses for this study are based on discussions in earlier sections. To further analyze the research questions and set other hypotheses considering the relationships of chosen variables, a concept model of the relationships between the variables is defined in Figure 2-9.

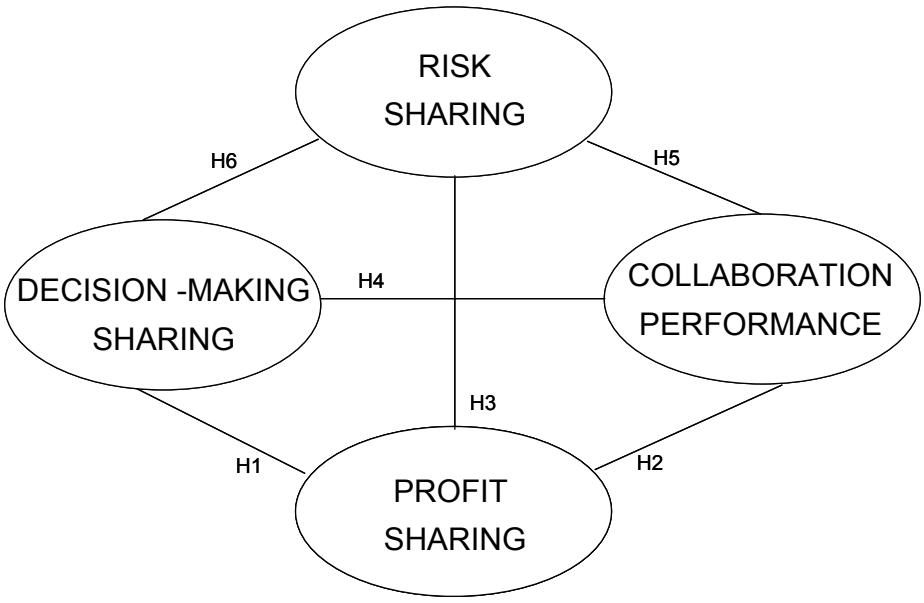

Figure 2-9. Concept model of the relationships between profit-sharing, risk-sharing, decision-making, and collaboration performance

As discussed by Simatupang et al. (2002), decision synchronization can be seen as the process in which the decision rights are assigned to particular chain members within the supply chain who are then accountable for the results. Adapting this approach, the decision-making sharing is considered in this study as a practical instantiation of implementing profit- and risk-sharing in the collaboration. If the risks and profits are shared, both companies should participate in making decisions related to the work to be done. Literature shows the linkage between the partnership relationship and decision-making sharing (Lejeune and Yakova, 2005; Brinkenhoff, 2002; Barratt, 2004; Simatupang and Sridharan, 2002). The first hypotheses can be therefore stated as follows:

> ***Hypothesis 1:*** *Profit-sharing has a positive effect on the sharing of decision-making.*

Some studies consider that partnership relationships have best performance (see e.g., Brinkenhoff, 2002; Mohr and Spekman, 1994). Profit- and risk-sharing have been incorporated as important features of partnership relationships in the literature (e.g., Ali-Yrkkö, 2001; Edelmann, 2001; Ellram and Edis, 1996; McIvor and McHugh, 2000;

Lambert et al., 1996). Fair profit-sharing is asserted as success factor in partnerships (Womack et al., 1990; Das and Teng, 1998; Day, 1995; Dwyer et al., 1987; Jarillo, 1998; Jarillo and Ricart, 1987; Hallikas, 2003; Lee, 2004; Narayanan and Raman, 2004). For the hypotheses construction, it is assumed that findings from these previous studies in the area of parcelled goods can be exploited in software development and the second hypotheses is defined as follows:

Hypothesis 2*: Profit-sharing has a positive effect on collaboration performance.*

It is agreed in the literature that risk- sharing is a cost of profit-sharing in the interorganizational relationship. The variables risk- and profit-sharing can be seen as latent variables (Tsay, 1999; Das and Teng, 1998; Day, 1995). Therefore, it can be assumed that risk-sharing would also affect the software development collaboration success with profit-sharing. The third hypotheses is stated as follows:

Hypothesis 3*: Profit-sharing has a positive effect on risk-sharing.*

There is a positive linkage between performance and joint decision-making found in the existing studies (Simatupang and Sridharan, 2008; Kim and Oh, 2005). The following hypotheses can therefore be constructed on the relationship between decision-making sharing and collaboration performance:

Hypothesis 4*: Decision-making sharing has a positive effect on collaboration performance.*

Profit-sharing was deduced to have a positive effect on collaboration performance. Also, profit- and risk-sharing were deduced to be latent variables. Risk-sharing has been incorporated as an important feature of partnership relationships in the literature (e.g., Ali-Yrkkö, 2001; Edelmann, 2001; Ellram and Edis, 1996; McIvor and McHugh, 2000; Lambert et al., 1996), which is considered to be the relationship type that has the best performance (e.g., Brinkenhoff, 2002; Mohr and Spekman, 1994). Therefore the following hypotheses can be constructed:

Hypothesis 5: *Risk-sharing has a positive effect on experienced collaboration performance.*

When profit- and risk-sharing are determined as latent variables, and sharing of decision-making is considered as an instantiation of proper deployment of profit- and risk-sharing, the relationship between sharing of decision-making and risk-sharing could be deducted as the last hypotheses:

Hypothesis 6: *Sharing of decision-making has a positive effect on risk-sharing.*

3. RESEARCH METHODOLOGY

3.1. Research design

This study aims to define how the software development collaboration performance is defined by the collaboration participants, and identifying what are the implications of collaboration performance on the attributes of profit-, risk-sharing, and sharing of decision-making. The research problem, the goal of the research, the possibilities provided by the data and the research methods, the criteria set for the research results, and the evidence that is needed should all be considered while making the selection (Olkkonen, 1994). Because of the need to be able to answer both "how" and "what" elements in this study, the mixed methods research approach was chosen. Mixed methods research approach can be seen as a third option in parallel with quantitative and qualitative approaches (e.g. by Creswell, 2003). Mixed methods are based on pragmatism, where the focus is on consequences, in addition to the textual meanings depending upon the contexts in which the consequences are studied (Cherryholmes, 1994). In mixed method approach, the both quantitative and qualitative methods are used. Typically both open and closed questions are used, an analysis includes both statistical and text analysis.

The first research question in this study aims to understand how the collaboration performance is defined by the collaboration participants. To achieve the definition for the performance, the definitions by the participants were analyzed qualitatively. For the second and third research questions, the implications of the attributes of profit-, risk-sharing, and sharing of decision-making and collaboration performance were analyzed quantitatively.

In this study, concurrent triangulation was chosen as a research strategy. In the strategy of concurrent triangulation, both the quantitative and qualitative data are collected

simultaneously. The results of the qualitative and quantitative methods are integrated in the interpretation phase. Creswell (2003) further describes both the advantages and limitations of this strategy. As the advantages of this strategy, the well-validated and substantiated findings and shorter data collection period are described. Effort and expertise to adequately study the phenomenon in two separate methods is needed and there can be difficulties to resolve discrepancies that may rise in the results are described as limitations.

3.2. Operationalization of the measurements

All concepts have two kinds of determinations: theoretical and operationalized (Eskola and Suoranta, 1999). The theoretical determination relates the concept to other concepts and theory, whereas the operationalized determination relates the concept to the observations of the concept in concrete reality. Researchers are advised to keep measurements as much as much possible in real terms, close to how things happen in real life (Mintzberg, 2005). To measure a phenomenon, measurable definitions are needed to identify the phenomenon. These are made by operationalization of the measurements (Metsämuuronen, 2003). The importance of operationalization has been emphasized, as it determines the quality of the measurement. In this section, the operationalization of the measurements in this study are discussed and defined.

The scope of interorganizational relationships in the answers is not restricted to some detailed relationship types. It is presumable that the respondents can interpret the terms used in interorganizational relationships differently, as the terminology is used inconsistently in the literature also. Because of these reasons, a very generic term "sourcing" is used in the operationalization of "collaboration," including all types of interorganizational relationships. This term is not in line with the concept analysis in Chapter 2 but is commonly used to describe the activities related to all relationship types in practice.

The measurement of "performance" of software sourcing would also be quite difficult, because different interpretations by respondents would be presumable. In practice, the goal of business is always good performance, which can be determined as success.

Therefore, the operationalized measure of performance is defined as "success." Because success is difficult to measure numerically, the critical incidence technique (CIT) was used to find the experiences of "most successful" and "most unsuccessful" cases from the participants.

The measure model for the relationship between the measurements was illustrated in Figure 2-9. As there is no existing scale to measure all of the attributes of risk-sharing or decision-making that could be directly applied to the context of software development and telecommunications collaboration, the attributes were constructed from the literature study.

Experienced collaboration performance is measured as experienced sourcing success (ES). It is considered as a single-indicator latent variable and measured as an experienced factor; it describes how the respondents have experienced it in their working history. This is done by using the CIT in the questionnaire and collecting answers on two cases, the most successful case and the most unsuccessful case, from each respondent. There are two indicators for sourcing success: most successful case and most unsuccessful case. The measurement model for sourcing success is described in Figure 3-1.

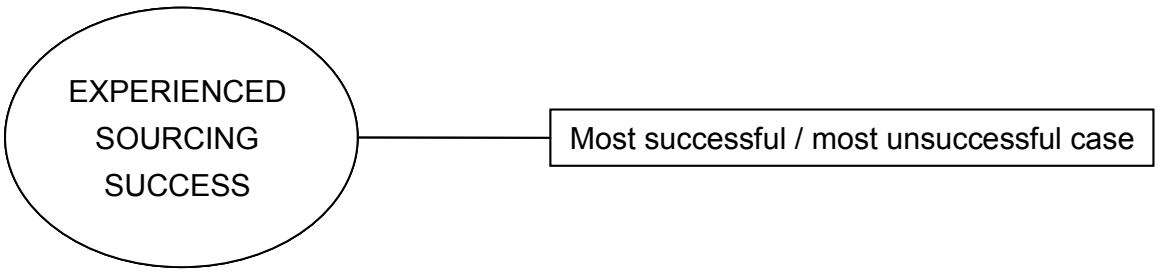

Figure 3-1. Measurement model for experienced sourcing success (ES)

Profit-sharing is considered here as a single-indicator latent variable. It is measured by the different levels at which profits can be shared between the two companies in software development. The measurement model for profit-sharing is illustrated in Figure 3-2.

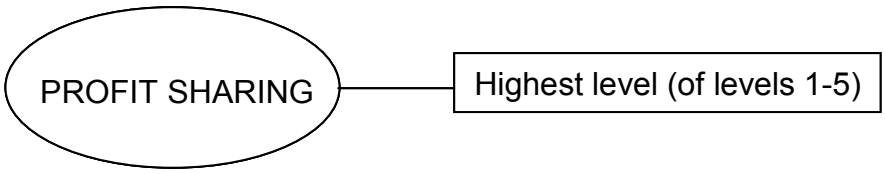

Figure 3-2. Measurement model for profit-sharing (PS)

On the basis of the literature review, five different profit-sharing levels were modified from the models of Ali-Yrkkö (2001) and Karjalainen et al. (2004). The different levels are on a scale of five levels. In three levels, all the possible differences in profit-sharing possibilities could not be taken into account (Metsämuuronen, 2003). On the other hand, when using more levels, the differences between the levels would become too minor in this case.

As discussed earlier, the respondents can choose several different profit-sharing levels. For quantitative analysis, the highest profit-sharing element in the answers is considered. The operationalized levels of profit-sharing are illustrated in Table 3-1.

Table 3-1. Operationalised levels of profit sharing and their abbreviations in SEM

Profit sharing level	**Abbreviation**
Subcontracting; hour based price	profit_1
Fixed, contracted price	profit_2
Extra bonus with specified criteria	profit_3
Part of the payment tied into profits	profit_4
Partnership; profits and risks shared	profit_5

The measurement of risk-sharing in numerical values would be difficult. The measurement would happen *ex post*, and because of the software development risks, the monetary value would be very difficult to estimate from the risks that were not encountered. On the basis of the literature research, the list of risk items in the context was constructed. The measurement model for risk-sharing (RS) is illustrated in Figure 3-3.

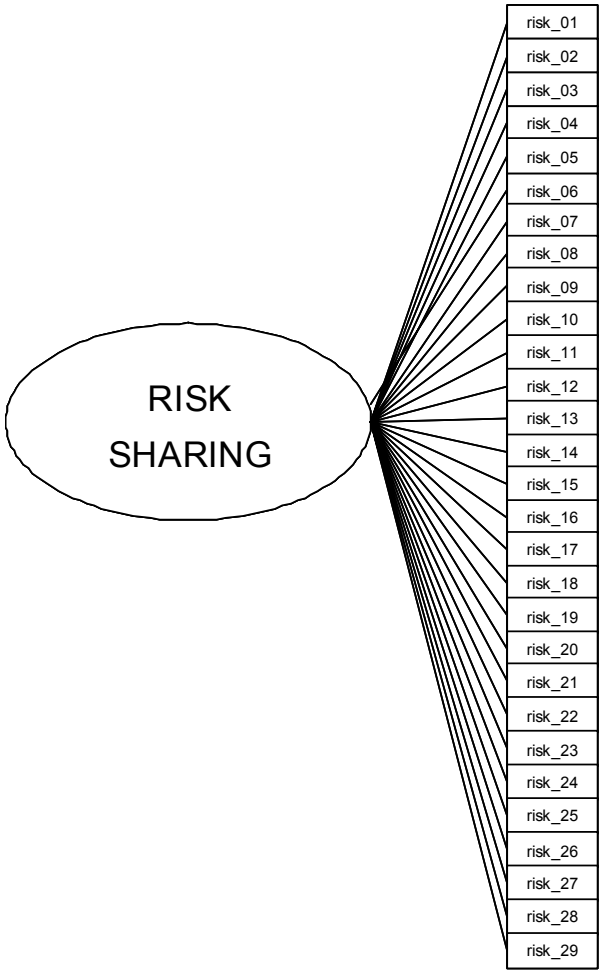

Figure 3-3. Measurement model for risk-sharing (RS)

Risk-sharing of each risk item between the companies was measured by a five-step scale that considers which company made the decisions (our company had all the risk; our company had most of the risk, but there was also some risk for the other company; the risk was divided evenly between the companies; the collaboration partner had most of the risk, but there was also some risk for us; the collaboration partner had all the risk). The risk items in the questionnaire as well as their abbreviations are presented in Table 3-2.

Table 3-2 Risk items in the questionnaire and their abbreviations in SEM

Risk item	**Abbreviation**
Developing a wrong kind of user interface	risk_01
Developing wrong functionality	risk_02
Product not meeting requirements	risk_03
Performance problems	risk_04
Technical problems in product	risk_05
"Gold-plating"; building a fancy UI etc. at the cost of functionality and features	risk_06
Risk to fail maintaining the product	risk_07
Risk not to be able to enhance the product as planned	risk_08
Cost overruns	risk_09
Schedule slippages	risk_10
Work amount estimation failure	risk_11
Need for doing rework	risk_12
Organisation related risks	risk_13
Collaboration contract cancellation	risk_14
Problems in collaboration contracts and litigations	risk_15
Lack of competent personnel	risk_16
Incorrect resource usage	risk_17
Personnel management risks	risk_18
Competition inside teams	risk_19
Problems in trust and values	risk_20
Company barriers preventing natural interaction between software designers	risk_21
Over-promising software capability in the contract before everything is understood	risk_22
Introducing too many new features to the product during development, and building a project that is too complex and large	risk_23
Strategic risks	risk_24
Business failure	risk_25
Loss of business credibility	risk_26
Litigations	risk_27
Issues that tarnish company image	risk_28
Loss of revenue	risk_29

Also the sharing of decision-making is measured by a five-step scale that considers which company made the decisions (our company decided; our company decided, but there was also some contribution from the other company; both companies decided together; the collaboration partner decided, but there was also some contribution from us; the collaboration partner decided). The measurement model for decision-making sharing is illustrated in Figure 3-4.

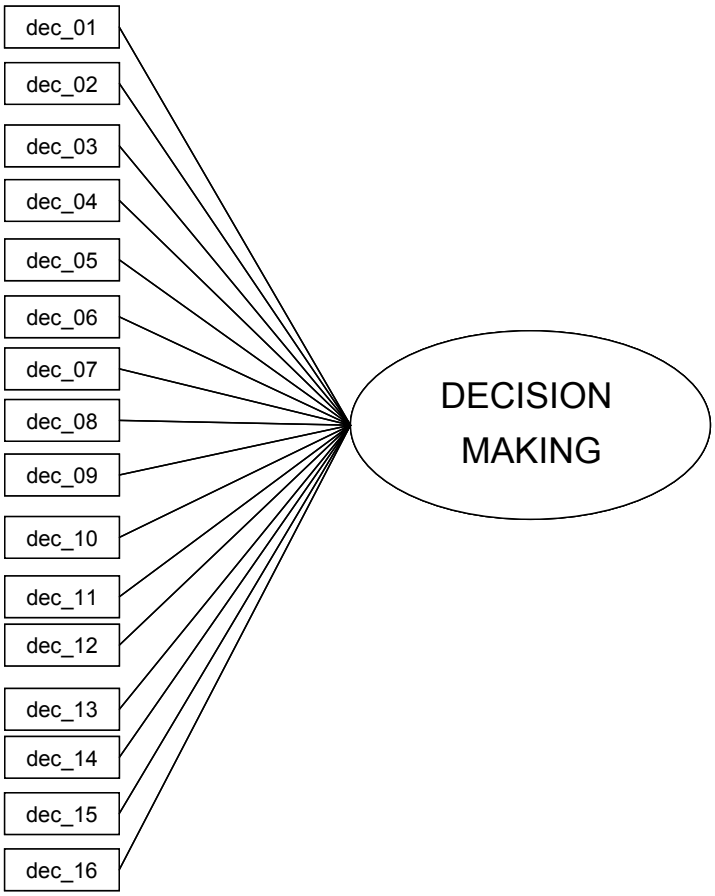

Figure 3-4. Measurement model for decision-making sharing (DM)

The decision items were derived from the literature study on software development project risks by evaluating the upper level items that need decision-making of which companies are responsible for sharing profits. These decision items are illustrated in Table 3-3.

Table 3-3. Decision types in the questionnaire and their abbreviations in SEM

Decision type	**Abbreviation**
Project timetable	dec_01
Project targets	dec_02
Project budget	dec_03
Personnel to be used in the project	dec_04
Technologies to be used	dec_05
Process models to be used	dec_06
Tools to be used	dec_07
Knowledge development of the collaboration company's personnel	dec_08
Risk identification methods	dec_09
Risk prevention practices	dec_10
Plans in the case of risk realisation	dec_11
Information sharing practices	dec_12
Model of cooperation between the companies	dec_13
Profit sharing between the companies	dec_14
Risk sharing between the companies	dec_15

3.3. Research methods

The research methods and research process used in this study are illustrated in Figure 3-5. The research can be divided into three phases; content analysis, structural equation modelling and multivariate analysis of variance.

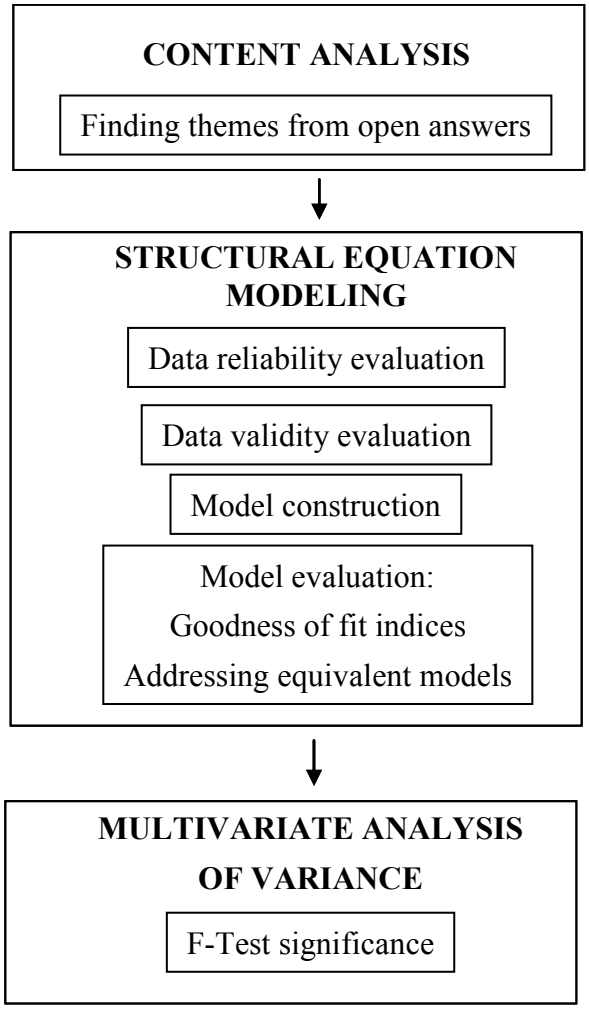

Figure 3-5. Research process and methods

Content analysis consists on finding themes that are included into respondents open answers for definitions of sourcing success. These themes give the answer to the first research question as the definition of collaboration software development performance by the participants of the collaboration. Second phase, structural equation modelling,

includes sub-phases as evaluation of reliability and validity of the data, model construction and the evaluation of the constructed model. By the structural equation modelling, the answer is found for the second research question as the attributes of risk-sharing, profit-sharing and sharing of decision making that influence performance in software development collaboration. For the last research question, if the collaborator role changes the influences of attributes of risk- and profit-sharing and sharing of decision-making with regard to performance in software development collaboration, the answer is found by multivariate analysis of variance. The differences between the respondent groups are found by F-test significance. These all methods are more discussed in the next chapters.

3.3.1. Content analysis

Content analysis has been defined as a systematic, replicable technique for compressing long texts into fewer content categories, "chunks," based on explicit rules of coding (Stemler, 2001; Rossman and Rallis, 1998). It was used in this study for finding the themes that were included in the definition of software collaboration by the collaboration participants. Anttila (1989) and Eskola and Suoranta (1999) describe the process of finding themes and codes in the answers. The common elements included in the answers are coded, and themes are constructed from the codes. When the themes are constructed, common elements and their variations between the respondent groups are taken into account.

As the threats to validity and reliability for the concept analysis, Weber (1990) shows the importance of reliability and consistency of classification procedure. Different people should code the same text in the same way. To decrease mistakes and individual differences in these interpretations, coding and grouping into themes have been carried out twice as advised by Eskola and Suoranta (1999) with a two-week interval.

3.3.2. Structural equation modelling (SEM)

The implications of profit-sharing, risk sharing, and sharing of decision-making attributes of collaboration performance were analyzed in two phases. First, structural equation modelling (hereafter SEM) is used to describe relationships of the attributes in all the responses.

SEM is not a single, separate statistical method but a family of statistical techniques. It can be defined as a family of statistical techniques that incorporates and integrates path analysis and factor analysis (Garson, 2008). Synonyms for SEM include covariance structure analysis, confirmatory factor analysis, linear structural relationships, and latent variable modelling (Scumacker and Lomax, 2006), covariance structure modeling (Kline, 2005), and Lisrel modelling (Steiger, 2001; Liping et al., 2009), which is related to a software tool for carrying out SEM.

Generally, SEM is a powerful method that can take into account modeling of interactions, nonlinearities, correlated interdependencies, measurement errors, correlated error terms, multiple latent independents that are measured by multiple indicators, and one or more latent dependents with multiple indicators (Garson, 2008; Shah and Goldstein, 2006). SEM can test relationships among multiple dependent and independent variables simultaneously (Henley et al., 2006). SEM can also have more flexible assumptions, test overall models instead of testing coefficients individually, test models with multiple dependents, and handle difficult data (Garson, 2008). Because of these advantages, SEM is recommended when the research problem has only one dependent variable, and the dependency is postulated among the independents (Garson, 2002). Because of its benefits SEM is widely used in different academic fields (Nusair and Hua, 2009; Liping et al., 2009; Shah and Goldstein, 2006).

However, SEM also has disadvantages and problems. The existence of equivalent models and improper solutions is seen as the often neglected challenges in SEM (Henley et al., 2006; Chen et al., 2001). Equivalent models are alternative models in which the data fit equally well and produce the same covariance or correlation matrix and goodness-of-fit statistics while differing significantly in the theoretical

interpretation (Henley et al., 2006). A five-step plan is presented by Henley et al. (2006) to address equivalent models in SEM research. The potential equivalent models of the constructed model are identified by (1) changing the direction of causal relationships and (2) replacing one parameter at a time with another parameter by the replacing rule presented by Raykov and Penev (1999). Improper solutions are estimates that take on values that would be impossible for the corresponding parameters or that are constrained to the boundaries of possible values (Chen et al., 2001): for example, correlation values over 1.0.

These challenges in SEM must be considered from the beginning of the analysis. The five-step plan for addressing equivalent models in SEM by Henley et al. (2006) is used in this study. The possibility of improper solutions is considered during the model construction. The limitations of the structural equation model will be further discussed in Section 6.4.

3.3.3. Multivariate Analysis of variance (MANOVA)

To understand the differences between the respondent groups, the differences and similarities between the groups were analyzed by multivariate analysis of variances (MANOVA).

ANOVA is a tool for a quantitative evaluation of the influence of the independent variables on the dependent variable. ANOVA methods can further be defined as one-way ANOVA or multiple (two-way or three-way) ANOVA depending on the number of points of views based on which the data must be classified (Sachs, 1984). In the case of multivariate analysis of variance, there are several dependent variables in place (Garson, G. David, 2009a). The *F*-test of differences of group means can be considered as a key statistic of ANOVA. The *F*-test ascertains if the means of the groups that are formed by values of the independent variables are different enough not to have occurred by chance. When the group means do not differ significantly, it can be concluded that the independent variable does not have an effect on the dependent variable. When the *F*-test gives a statistically significant value, it can be concluded that the independent variable

accounts for the variability of the dependent variable (Garson, 2009a; Metsämuuronen, 2003).

A limitation of MANOVA is that it detects only the statistically significant differences among group means but does not indicate the functional form of the relationship among group means (Buckless and Ravenscroft, 1990). However, this is not a limitation in the present study because SEM is used in addition. Another limitation of MANOVA is the sample size that will be discussed within the limitations of the study in Section 6.4.

3.4. Data

Questionnaires are widely used in the business studies because of their benefits as ease in collecting large samples, effectiveness, ease of scheduling, estimating costs, and saving data in a preferred way and analyze them by a computer with already developed statistical tools (Hirsjärvi et al., 1997). In addition to these benefits, questionnaires include deficiencies that the researchers are advised to be aware of. Interpretation of the results can be difficult because of the missing information on how honest and accurate the responses are, and the response rates can be low (Gummesson, 1993). Also, the problems that relate to both open and closed questions in the questionnaires has been discussed (e.g. Schuman and Presser, 1979; Schuman and Presser, 1979).

The benefits of using the questionnaires in the survey were considered very suitable to this study. The respondents were geographically distributed. As all respondents have easy access to the Internet, the questionnaire posted in the Internet was considered to lead to higher response rates when compared to the questionnaire in the paper form. The survey was carried out by using the SurveyMonkey.com survey software service (www.surveymonkey.com). The survey questionnaire is presented in Appendix 1. The challenges within the questionnaire were decreased by taking them into account in planning and interpreting the results. As advised by Gummesson (1993) , Czaja and Blair (2005) and Olkkonen (1994), the respondents were selected carefully by defining the criteria that the respondent needs to fulfill, and the questionnaire was tested to be suitable for the research goals before conducting the actual survey.

To find the most successful and unsuccessful collaboration cases that the respondents experienced, critical incidence technique (CIT) was applied in the questionnaire questions. The CIT is a technique for a qualitative interview procedure. It facilitates the significant occurrences, the event incidents, and processes or issues that are identified by the respondent, and gives information on how they were managed and what their effects were. The objective of the CIT is to give an understanding of the incident from the perspective of the individual, and the CIT takes into account cognitive, affective, and behavioural elements (Symon and Cassell, 2004).

In this study, the CIT was used in the questionnaire to find the respondent's extreme experiences of collaboration performance (operationalised as success), both positive and negative. In the questionnaire, the respondents were asked to identify most successful and most unsuccessful collaboration cases that they participated in, and answer the questions from those cases in order to identify the characteristics of the cases and the experiences. This made the questionnaire quite long (twice answering same questions on the characteristics of the collaboration cases) and affected the answering rate, but gives interesting comparisons and analyses of the experienced performance of different collaboration cases.

The definition of performance, operationalized as success, was asked in three different open-ended questions: first in the defining of a questionnaire in a question of the generic definition of success, and later as reasons for identifying the most successful or most unsuccessful cases. Open questions were used to get spontaneous answers from the respondents, without creating any ready characterizations of the term beforehand.

The attributes of profit-, risk-sharing, and sharing of decision-making were measured with closed questions as operationalized earlier. These were measured separately from both most successful and most unsuccessful cases. Profit-sharing was measured as multiple-choice questions. Risk-sharing and sharing of decision-making were measured as single-choice questions.

In order to get the overall view on the collaboration, respondents from two OEMs and their selected supplier companies were included in the survey. Four different respondent groups can be identified: OEM1, OEM1 suppliers (SUPP1), OEM2, and OEM2

suppliers (SUPP2). OEM1 and OEM2 represent typical companies in the telecommunications industry. They are relatively large and operate globally. Collaborator groups consist of small and medium-sized companies that work as software development suppliers. Companies are headquartered in several countries, and most work globally. It was known before the survey that OEM2 had used more profit- and risk-sharing collaboration business models that can be seen as true partnering, while OEM1 had not implemented this kind of business models much.

For the quality of the results, the respondents of the survey were considered critical. The criteria for choosing the respondents was to have respondents who have participated in different kinds of collaboration modes and had knowledge of collaboration case execution, its success, and the collaboration mode of each case. The persons fulfilling these criteria were chosen by the researcher (OEM1 respondents), OEM interface persons for suppliers (OEM1 supplier respondents), and persons responsible for collaboration (OEM2 respondents and OEM2 supplier respondents).

4. RESULTS

4.1. Response rate

The respondents who answered the survey in OEMs had occupied managerial positions in software sourcing and were responsible for contracts, R&D, project management, relationship management, or sourcing strategies. These respondents represented several different organizational units and functions (R&D, project management, sourcing). From suppliers, the respondents were the counterparts of these OEM people: project managers overseeing the OEM projects, account managers, people responsible for customers and contracts, and people selling the software sourcing services. OEM2 supplier responses include responses from two companies and respondents from different locations working in different projects. OEM1 supplier responses consist of responses from 15 companies, each response being from a separate company.

The response rate for the survey was enforced by organizing a lottery among the respondents, providing the results of the survey to the respondents, using the sourcing managers of the companies as the references in the invitations, and sending reminders of the survey to the respondents (OEM1 and its collaborators on February 8, 2008, OEM2 and its collaborators on February 12, 2008). The survey was open from January 13, 2008 to June 4, 2008. The response rates are presented in Table 4-1.

Table 4-1.Number of invitees, responses and the response rates of the survey

Company	**Invitees**	**Responses**	**Response rate**
OEM1	161	24	6.7%
SUPP1	36	15	41.6%
OEM2	15	7	46.6%
SUPP2	35	15	42.9%
OEM companies total	176	31	17.6%
Suppliers total	71	30	42.9%
TOTAL	247	61	24.7%

The response rate was lowest within OEM1, even when the number of invitees grew by the time as new contact persons were included in the survey to increase the number of respondents. This could be a consequence of the timing of the questionnaire, as many other questionnaires were ongoing at OEM1 at the same time. In general, there were more respondents from sales and sourcing than from R&D departments. Also, the questionnaire was rather long and has sections for both most successful and most unsuccessful cases. There were a couple of cases where the response was discontinued at the beginning of the second section. In these cases, only the first section was used in the analysis.

4.2. Performance definition by collaboration participants

The experienced software development collaboration performance was analyzed according to the process proposed by Anttila (1989) and Creswell (2003) with the details for finding themes and codes by Eskola and Suoranta (1999). First, definitions of software development collaboration performance were collected from the responses to question 3 in the questionnaire: "*How would you determine success in software sourcing?*" The open answers are included in Appendix 2.

The answers were first analyzed separately for each respondent group (OEM1, SUPP1, OEM2, and SUPP2). The responses of each group were coded and organized by themes. Multiple classifications were used; a response could be classified into more than one theme. This phase was done with the help of mind maps and it was carried out twice in order to avoid individual misinterpretations as suggested by Eskola and Suoranta (1999). Answers that indicated that the respondent had misunderstood the question were dropped (seven answers in OEM response groups, two answers in supplier response groups). After the responses were organized into themes, the themes from OEM1 and OEM2 were combined, and in consonance, the themes from SUPP1 and SUPP2 were combined because of the congruence of the answers. In this phase, some modifications to the theme names were made to make the terminology more consistent. These modifications are by combining "requirements" with "functionality," "time" with "schedule," "ownership of the area" with "responsibility," and "price" with "cost."

After the features of most successful and most unsuccessful collaboration cases were answered, questions 17 and 34 were asked why respondents identified these collaboration cases to be most unsuccessful and most successful. These answers were analyzed and compared to the determinations of sourcing success and to find out what are the elements that were raised most in these cases.

4.2.1. Performance definitions in OEM company answers

The themes found from the open definitions for sourcing success as well as how many times these themes are used as the reasons for identifying the most successful or most unsuccessful case in OEM responses are summarised in Table 4-2.

Table 4-2. Performance themes and their mentions in OEM responses

Element	Nbr of mentions in open definitions	Reason for identification of most successful	most unsuccessful
Time and schedule	13	3	5
Finance, cost and price	12	7	5
Relationship related	11	12	4
Software quality	10	5	2
Functionality and requirements	8	7	4
Strategic items	3	2	1
Ownership and responsibilities	3	1	0
Competence	3	3	4
Work planning	1	1	3
Tools and methods	1	1	0
Suppliers flexibility	1	7	0
Achieved customer value	1	0	0
Resourcing	0	1	1
People related	0	2	0
Business volume, growth and continuation	0	0	0

Time or schedules is found to be mentioned the most (13 mentions). For time and schedule, the criteria for keeping the agreed schedule or delivery time are the most common item (11 mentions). In two of these answers, a successful collaboration brought scheduling benefits and was quicker than in-house development. Financial items received 12 mentions, of which five answers had the response of lower costs because collaboration was cheaper than in-house development. The factor “keeping the agreed costs” was mentioned four times and included definitions of the agreed or planned price, and required costs. Other mentions of financial items were related to the element of low costs that was mentioned four times and defined as the competitive price, right level of investment, cost effectiveness, and reasonable cost.

Relationship-related items were mentioned 11 times in the open definition of success. These were scattered very broadly. The win–win situation was mentioned three times, and the long-term relationship twice. Other mentions were single mentions of understanding between the partners, trust, cooperation, open and frequent communication, open discussion on problems and issues, and development of issues and processes together.

Software quality was the theme that was included as fourth highest mention in the answers with ten mentions. Within this theme, “receiving the planned quality” was the most mentioned response with six mentions. This was stated as “required quality,” “required or higher quality,” “acceptable or adequate quality,” “meeting the quality,” or

"keeping the planned quality." One answer related the existence of inbuilt quality to success, and others the mentioned as good, high, or competitive quality.

Definitions also often referred to functionality and requirements of the collaborated work (eight mentions). The response "receiving the required functionality" was mentioned six times and described as providing defined functionality, meeting the requirements, right deliverables, getting what was required, and work according to the plan. One answer related receiving extra functionality for success.

Other definitions were related to suppliers' competence, clear ownership or responsibilities, flexibility of the collaborator company, strategic items, items related to good planning, and effective tools and methods. There was no mention of resourcing, business volume growth and continuation, or people-related items.

The relationship-related items were most frequently mentioned as the reasons for the most successful cases. Other items were related to functionality and requirements, suppliers' flexibility, and financial items. The reasons for most unsuccessful cases mentioned items related to financial items, time and schedule, relationship-related items, competence, functionality, and requirements. These were mentioned in the context of not keeping the agreed time or costs, not delivering what was agreed, or not having enough competence on the suppliers' side.

The responses from OEM1 and OEM2 are very similar. The elements that are mostly mentioned are identical with couple of exceptions. OEM2 responses included the competence of the supplier in open definitions more than OEM1 responses. Items of the ownership and responsibilities, work planning, achieved customer value, and tools and methods were not mentioned at all in OEM2 responses.

4.2.2. Performance definitions in supplier company responses

The themes found from the open definitions for software development collaboration success as well as how many times these themes were used to identify the most successful or most unsuccessful case are summarized in Table 4-3.

Table 4-3. Performance themes and their mentions by collaborator companies

Element	Nbr of mentions in open definitions	Reason for identification of most successful	most unsuccessful
Relationship related	23	19	5
Finance, cost and price	11	3	2
Software quality	8	0	0
Business volume, growth and continuation	5	4	2
Achieved customer value	5	1	1
Functionality and requirements	4	0	4
Suppliers flexibility	4	0	0
Strategic items	3	2	1
Resourcing	2	0	1
Competence	2	1	1
Ownership and responsibilities	2	1	5
People related	2	1	0
Time and schedule	1	1	0
Work planning	1	0	3
Tools and methods	0	0	2

Relationship-related items were most often used in the success definitions by collaborator companies and mentioned 23 times. Win–win business relationships and communication between the companies were both mentioned four times. Other popular items were mutual benefits between the partners and trust (three mentions for both), and cooperation (two mentions). Individual mentions were given to understanding between the partners, long-term relationships, close relationships, risk-sharing, sustainability of relationships, received focus from top management, relationships to fulfill business requirements, information flow, and identification of risks together.

Finance/cost/price-related items were mentioned 11 times. These were related to offering work at a lower cost or competitive price for the OEM (three mentions), long-term profitability (two mentions), cost performance, healthy margin from the account, and keeping the project in budget.

Business growth, volume, and continuation and achieved customer value both had five mentions. Continuation and growth of business was seen as a factor for success. Achieved customer value was related to customer satisfaction.

The relationship items were the most often mentioned items to identify the most successful cases. Successful cases were also identified by business volume, growth, and continuation. In identifying most unsuccessful cases, items related to the relationship,

ownership, and responsibilities were mentioned most often, followed by functionality and requirements.

In both SUPP1 and SUPP2 groups, the relationship items were most often mentioned elements. The software quality and competence related items were also often mentioned in the open answers in SUPP2 responses but not mentioned in SUPP1 responses. SUPP1 responses also left out elements of tools and methods, work planning, people-related items, and ownership and responsibilities themes.

4.3. Influences of attributes of profit-, risk-sharing, and and sharing of decision-making to collaboration performance

The second research question was stated as *"What are the attributes of profit-sharing, risk-sharing and decision-making sharing influencing performance in software development collaboration?*" The results of the survey were analyzed through structural equation modelling to find out the answer for this question. First, the reliability and validity evaluation for the collected data is analyzed, followed by the construction of structural equation modelling.

4.3.1 Reliability and validity evaluation for the data

Internal consistency reliabilities of the data was first analyzed by correlation analysis by using the SAS Enterprise Guide software version 4.1. The results are presented in Table 4-4. Standardized variables were used. In this phase, the constructs, risk_16, risk_17, risk_18, risk_19, risk_20, risk_21, risk_22, dec_04, and dec_08, were removed from further analysis because of their low correlation value (<0.6). All other constructs have a correlation value above 0.6.

Table 4-4. Statistics for latent variables risk sharing (RS) and decision-making sharing (DM)

Item		**N**	**Mean**	**Std Dev**	**Correlation with total ***	***Cronbach's alpha** *
RS						*0.967*
risk_01	Developing a wrong kind of user interface	119	2.714	1.263	0.740	*0.965*
risk_02	Developing wrong functionality	119	2.782	1.243	0.776	*0.965*
risk_03	Product not meeting requirements	119	2.815	1.308	0.842	*0.965*
risk_04	Performance problems	119	3.034	1.221	0.773	*0.965*
risk_05	Technical problems in product	119	2.924	1.257	0.801	*0.965*
risk_06	"Gold-plating"; building a fancy UI etc. at the cost of functionality and features	119	2.874	1.246	0.814	*0.965*
risk_07	Risk to fail to maintain the product	119	2.950	1.227	0.761	*0.965*
risk_08	Risk not to be able to enhance the product as planned	119	2.924	1.215	0.751	*0.965*
risk_09	Cost overruns	119	2.916	1.357	0.834	*0.965*
risk_10	Schedule slippages	119	2.866	1.221	0.845	*0.965*
risk_11	Work amount estimation failure	119	2.958	1.349	0.789	*0.965*
risk_12	Need for doing rework	119	3.059	1.271	0.763	*0.965*
risk_13	Organisation related risks	119	2.975	1.218	0.744	*0.965*
risk_14	Collaboration contract cancellation	119	2.824	1.205	0.581	*0.967*
risk_15	Problems in collaboration contracts and litigations	119	2.924	0.940	0.704	*0.966*
risk_16	Lack of competent personnel	119	3.218	1.151	**0.443**	*0.968*
risk_17	Incorrect resource usage	119	3.319	1.193	**0.528**	*0.967*
risk_18	Personnel management risks	119	3.353	1.218	**0.502**	*0.967*
risk_19	Competition inside teams	119	3.185	1.089	**0.625**	*0.966*
risk_20	Problems in trust and values	119	3.000	0.911	**0.490**	*0.967*
risk_21	Company barriers preventing natural interaction between software designers	119	2.950	0.990	**0.495**	*0.967*
risk_22	Over-promising software capability in the contract before everything is understood	119	2.983	1.135	**0.575**	*0.967*
risk_23	Introducing too many new features to the product during development, and building a project that is too complex and large	119	2.933	1.205	0.725	*0.966*
risk_24	Strategic risks	119	2.790	1.327	0.695	*0.966*
risk_25	Business failure	119	2.748	1.348	0.711	*0.966*
risk_26	Loss of business credibility	119	2.815	1.359	0.723	*0.966*
risk_27	Litigations	119	2.882	1.180	0.670	*0.966*
risk_28	Issues that tarnish the company image	119	2.790	1.327	0.717	*0.966*
risk_29	Loss of revenue	119	2.840	1.396	0.797	*0.965*
DM						*0.929*
dec_01	Project timetable	119	2.588	1.440	0.727	*0.923*
dec_02	Project targets	119	2.571	1.493	0.676	*0.924*
dec_03	Project budget	119	2.580	1.411	0.735	*0.923*
dec_04	Personnel to be used in the project	119	3.479	1.119	**0.200**	*0.937*

dec_05	Technologies to be used	119	2.832	1.284	0.779	*0.921*
dec_06	Process models to be used	119	2.958	1.374	0.821	*0.920*
dec_07	Tools to be used	119	2.874	1.418	0.826	*0.920*
dec_08	Knowledge development of the collaboration company's personnel	119	3.378	1.172	**0.093**	*0.940*
dec_09	Risk identification methods	119	3.134	1.149	0.725	*0.923*
dec_10	Risk prevention practices	119	3.168	1.195	0.744	*0.922*
dec_11	Plans in case of risk realization	119	3.160	1.112	0.670	*0.924*
dec_12	Information sharing practices	119	2.966	0.892	0.815	*0.920*
dec_13	Model of cooperation between the companies	119	2.849	0.917	0.689	*0.924*
dec_14	Profit sharing between the companies	119	2.647	1.350	0.705	*0.923*
dec_15	Risk sharing between the companies	119	2.714	1.222	0.724	*0.923*

*Standardized variables.

In addition to the correlation with the total, the internal consistency reliability was analyzed by using Cronbach's alpha, also called "the reliability coefficient" in the literature. Values of Cronbach´s alpha vary from 0 to 1.0 (Garson, 2008). It has been proposed that the indicators should have Cronbach´s alpha of 0.7 to judge if the set is reliable (Garson, 2008; Garson, 2002). Another proposal for the value is that Cronbach's alpha should be 0.6 or higher to be accepted (Metsämuuronen , 2003). All of the measurement scales exhibit high reliability (Cronbach's alpha 0.8 or higher).

The validity of the measurements was analyzed by conducting a confirmatory factor analysis by using the Lisrel 8.8 software. The results are shown in Table 4-5. The *t*-value of the item dec_01 is under 1.96, indicating that the parameter is not significantly different from 0 in the population. Therefore, the item dec_01 was dropped from further SEM. For all the other items, the absolute value for the *t*-value is over 1.96.

For convergent validity, a value of average variance extracted (AVE) was calculated for the measurement constructs as advised by Karjaluoto and Juntunen (2007). The values for AVE are included in Table 4-5. According to Fornell and Larcker (1981), a model has a good convergent validity if at least 50% of measurement variance is captured by the construct, that is, if AVE value is greater than 0.5. For both measurement constructs, DM and RS, AVE value is well above the limit of 0.5.

Table 4-5. Statistics for confirmatory factor analysis

Measurement model	Indicator	Factor loading *	Error variance	t value	AVE **
PS	h	1.000	0.000	21.730	
ES	Succ	1.000	0.000	21.730	
DM	(dec_01)	0.080	0.990	**0.830**	0,86
	dec_02	-0.790	0.370	-22.060	
	dec_03	-0.750	0.440	-17.770	
	dec_05	-0.830	0.310	-27.680	
	dec_06	-0.870	0.240	-36.380	
	dec_07	-0.880	0.230	-37.240	
	dec_09	-0.900	0.200	-44.200	
	dec_10	-0.680	0.540	-13.340	
	dec_11	-0.660	0.570	-12.140	
	dec_14	-0.780	0.400	-19.890	
	dec_15	-0.700	0.510	-14.170	
RS	risk_01	0.740	0.450	17.890	0,93
	risk_02	0.810	0.340	25.040	
	risk_03	0.860	0.260	35.940	
	risk_04	0.900	0.200	47.630	
	risk_05	0.910	0.180	52.800	
	risk_06	0.810	0.350	25.020	
	risk_07	0.850	0.280	32.240	
	risk_08	0.880	0.220	41.550	
	risk_09	0.820	0.330	26.370	
	risk_10	0.850	0.270	32.790	
	risk_11	0.840	0.290	30.510	
	risk_12	0.820	0.330	26.380	
	risk_13	0.740	0.450	17.720	
	(risk_14)	0.700	0.520	14.540	
	risk_15	0.690	0.530	13.840	
	risk_23	0.430	0.820	5.680	
	risk_24	0.580	0.660	9.560	
	risk_25	0.760	0.430	18.780	
	risk_26	0.740	0.450	17.900	
	risk_27	0.730	0.460	16.860	
	risk_28	0.690	0.530	13.840	
	risk_29	0.640	0.590	11.740	

* Factor loading for standardized solution.

** AVE calculated for the items included in the analysis (items dec_01 and risk_14 dropped).

The profit-sharing level and experienced success were handled as single indicators. These two are supposed to be measured without error, as they are measured as experiences of the respondents. Basic statistics for these variables are included in Table 4-6.

Table 4-6. Single indicators for latent variables, experienced success (ES) and profit sharing (PS)

Item	**Definition**	***N***	**Mean**	**Std Dev**	**Correlation with total ***	**Cronbach's alpha ***
ES	Classification of most unsuccessful/ most successful case where participated	119	3.218	1.996	-	-
PS	Highest level of profit sharing in the case (1–5)	119	2.307	1.242	-	-

4.3.2. Relationships between the attributes

With the evaluations and deletions of variables described in the earlier section, the reliability and validity of the data were adequate to continue the analysis. Next ES, PS, RS, and DM were included in the structural equation model as latent variables, and the indicators selected in the previous chapter were included in the model. The model in Figure 2-9 was used as a basis for the structural equation model to be constructed. Some indicators for latent variables were dropped from the model because of their high error variance (>0.40) and low loading (<0.70) into the latent variable. During the model construction, some error covariances were set free as suggested by Lisrel modification indices in order to make the model fit better. The method of maximum likelihood estimation was used. The structural equation model constructed from the data is illustrated in Figure 4-1.

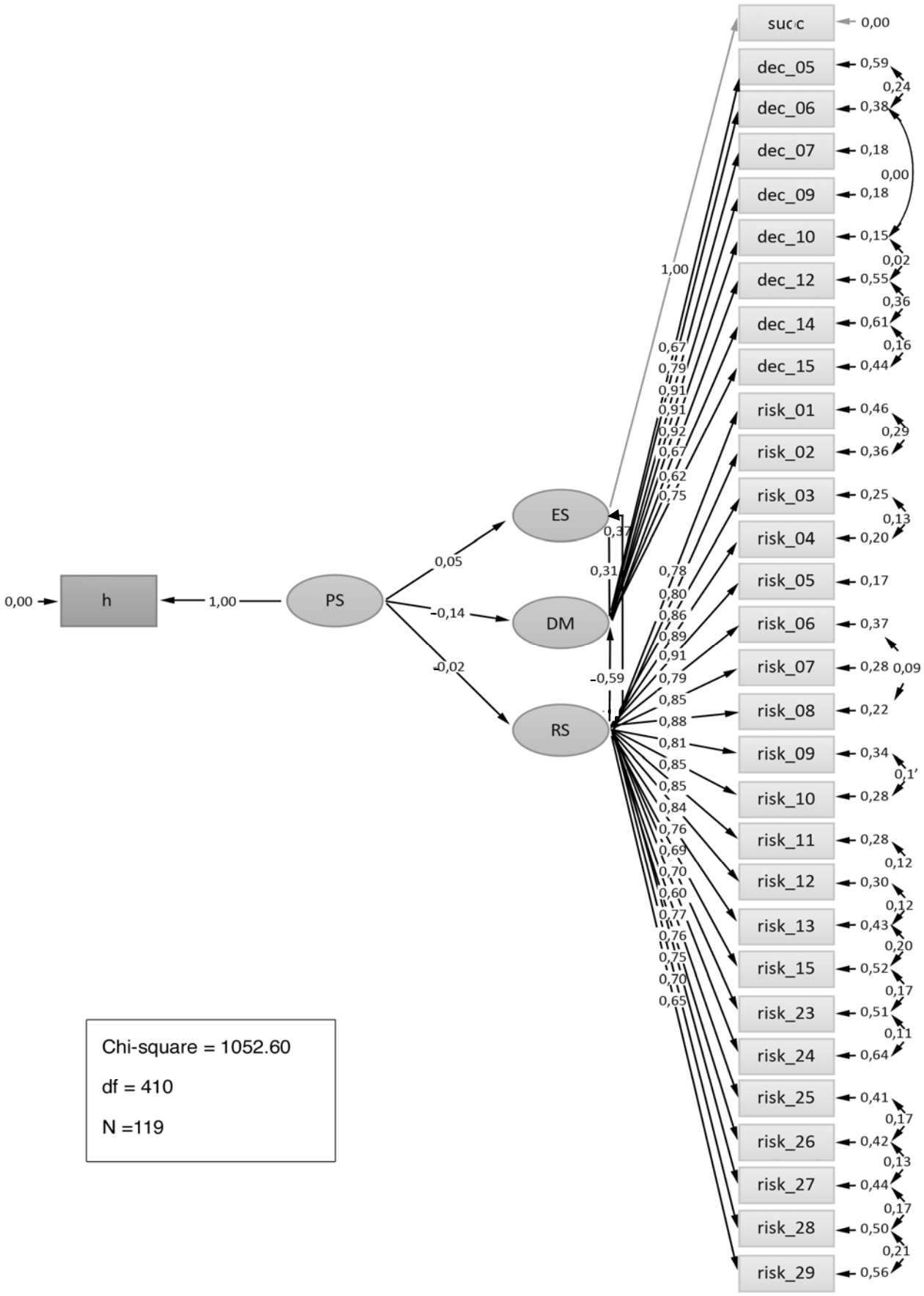

Figure 4-1. Structural equation model for the research data (data from OEM1, OEM2, SUPP1, and SUPP2 included).

Path coefficients from PS into ES, DM, or RS are not statistically significant (*t*-values between –1.96 and 1.96, meaning that the corresponding parameter is not significantly different from zero at the 5% significance level). Statistically significant path coefficients were confirmed from RS to DM and ES and from DM into ES. These relationships will be further analyzed in the following chapters.

The corresponding *t*-values, loadings, and errors for indicators are presented in Table 4-7. All indicators have statistically significant loadings, and *t*-values for any indicators is not between –1.96 and 1.96.

Table 4-7. Statistics for indicators in the constructed structural equation model

Indicator	Loading	T value	Error
Succ	1.00	-	0.00
h	1.00	21.79	0.00
dec_05	0.67	12.48	0.59
dec_06	0.79	15.89	0.38
dec_07	0.91	16.72	0.18
dec_09	0.91	16.73	0.18
dec_10	0.92	16.81	0.15
dec_12	0.67	10.90	0.55
dec_14	0.62	9.57	0.61
dec_15	0.75	14.89	0.44
risk_01	0.78	17.01	0.46
risk_02	0.8	23.41	0.36
risk_03	0.86	35.11	0.25
risk_04	0.89	44.31	0.20
risk_05	0.91	51.22	0.17
risk_06	0.79	23.02	0.37
risk_07	0.85	31.66	0.28
risk_08	0.88	40.92	0.22
risk_09	0.81	24.97	0.34
risk_10	0.85	31.97	0.28
risk_11	0.85	30.54	0.28
risk_12	0.84	25.68	0.30
risk_13	0.76	17.64	0.43
risk_15	0.69	13.13	0.52
risk_23	0.7	13.91	0.51
risk_24	0.6	9.89	0.64
risk_25	0.77	19.78	0.41
risk_26	0.76	18.29	0.42
risk_27	0.75	17.08	0.44
risk_28	0.7	13.76	0.50
risk_29	0.65	11.75	0.56

Lisrel produces 36 goodness-of-fit measures. The goodness-of-fit measures have their own limitations and benefits, and it has been widely discussed what goodness-of-fit measures should be used for analyzing the model (for example, Chin, 1998; Kelloway, 1995; Landis et al., 2000; Garson, 2008; Kline, 2005; Barrett, 2007; McIntosh, 2007). The sample size affects several goodness-of-fit measures (Landis et al., 2000). Taking

into account the sample size in this study, the set of goodness-of-fit indices proposed by Kline (2005) and supported by Garson (2008) was used to analyze the fit of the model.

The model can be approved by analyzing the goodness-of-fit measures proposed by Kline (1998, p. 130) and their recommended values (Garson, 2008). This selection of goodness-of-fit measures includes the non-normed fit index (NNFI), comparative fit index (CFI), and standardized RMR (SRMR). Their values in the constructed model are included in Table 4-8.

Table 4-8. Measures for the goodness-of-fit of the model

Fit indice	**Abbreviation**	**Criteria**	**Value**
Non-Normed Fit	NNFI	>= 0.95	0.95
Comparative Fit	CFI	>=0.90	0.96
Standardized RMR	SRMR	<0.10	0.09

Some equivalent models were identified during the model construction. They were identified by replacing rules or changed path directions as proposed by Henley et al. (2006) and Raykov and Penev (1999). Most of the models constructed did not produce similar goodness-of-fit statistics (SRMR being equal or greater than 0.1) and hence were not considered as equivalent models. The equivalent model is identified with a path between the latent variables RS and DM in other direction. This implies that the relationship between these variables would be bidirectional. When defining the measurement model, the latent variable DM is defined as the implication of the proper implementation of PS and RS. The ANOVA results that are presented in the next chapter (Chapter 5) show RS accounting to be statistically significant to DM inside the respondent groups. Therefore, this model was chosen as the constructed model, but the existence of those equivalent models must be noted. In other equivalent models, the path coefficients were not as strong as in the constructed model or were not supported by theory.

4.4. Differences in attribute influences by collaborator roles

To find out if there are differences in attribute influences between the respondent groups, comparisons between the means of the samples of different respondent groups are conducted with MANOVA with SAS EG 4.1. Welch's variance-weighted ANOVA is recommended in the case of unequal sample sizes within the groups (Garson, 2009a) and it was decided to be used here. The equal variances were tested with Levene's test, which is considered as the standard homogeneity of variance test (SAS EG 4.1. help). The results of the MANOVA tests for all variables are shown in Appendix 3. In the following sections, the results of MANOVA tests are summarized by describing only the significant results from *F*-tests.

In the implications of risk-sharing and sharing of decision-making, the collaborator types had differences between each others. In the influences of profit-sharing attributes on performance, differences were not found between the respondent groups. The *F*-test was not significant for the interaction of ES and PS in any respondent group, as described in Table 4-9.

Table 4-9. F –test for the interaction of ES and PS

Model							Welch's ANOVA		Significance
Dependent variable	Independent variable	Group	df	SS	MS	R Square	F	Pr>F	
Succ	h	OEM1	4	11.6912	2.92279	0.056786	0.1	0.9564	
		OEM2	3	22.9167	7.63889	0.314286	0.4	0.5454	
Succ	h	SUPP1	4	34.7778	8.69444	0.118091	1.89	0.1843	
		SUPP2	4	99.0821	24.7705	0.701197	0.15	0.71	

4.4.1. Risk-sharing attributes influencing collaboration performance

The structural equation model in Figure 4-1 shows statistically significant positive path coefficient from risk-sharing in experienced collaboration performance. When ES and RS are analyzed in the four respondent groups, significant *F*-tests for interactions between ES and RS attributes are received only in the supplier's responses. There is no significant interaction in either OEM response group with attributes of RS and ES.

Significant *F*-tests are received inside supplier groups for individual RS indicators. These indicators are different between SUPP1 and SUPP2 groups. The SUPP1 group shows interactions with several risk items and ES. The RS indicator, "loss of revenue" (risk_29), significantly account for ES. RS indicators, "product not meeting requirements" (risk_03), "need for doing rework" (risk_12), "collaboration contract cancellation" (risk_14), "issues that tarnish company image" (risk_28), "risk to fail to maintain the product" (risk_07), "strategic risks" (risk_24), and "loss of business credibility" (risk_26), significantly account for ES. These F-tests for interactions inside supplier groups are defined in Table 4-10.

Table 4-10. F –test for the interaction of RS and ES in supplier groups

Model							Welch's ANOVA		Significance
Dependent variable	Independent variable	Group	df	SS	MS	R Square	F	Pr>F	
Succ	risk_03	SUPP1	5	77.4861	15.4972	0.263111	5.25	0.0044	**
Succ	risk_07	SUPP1	5	51.5285	10.3057	0.174969	2.98	0.0479	*
Succ	risk_12	SUPP1	4	147.857	36.9643	0.502061	7.61	0.0044	**
Succ	risk_14	SUPP1	4	92.9848	23.2462	0.315738	5.77	0.0052	**
Succ	risk_24	SUPP1	6	77.4296	12.9049	0.262919	3.97	0.0174	*
Succ	risk_26	SUPP1	4	58.875	14.7188	0.199915	2.97	0.0423	*
Succ	risk_28	SUPP1	4	74.3232	18.5808	0.252371	5.38	0.0035	**
Succ	risk_29	SUPP1	4	95.5498	23.8874	0.324447	7.81	0.0007	***
Succ	risk_16	SUPP2	3	103.804	34.6014	0.734615	17.53	<.0001	***
Succ	risk_18	SUPP2	4	101.304	25.3261	0.716923	11.4	<.0001	***

In the SUPP2 group, only two RS indicators interact with ES. These two risk indicators, "lack of competent personnel" (risk_16) and "personnel management risks" (risk_18), significantly account for ES.

4.4.2. Sharing of decision-making attributes influencing collaboration performance

For the interaction between ES and DM, significant F-tests for interactions between ES and DM items are received only in supplier response groups. These are shown in Table 4-11. There is no significant interaction between ES and DM inside either OEM group. This indicates that DM does not account for the variability in ES from the OEM point of view.

In both supplier groups (SUPP1 and SUPP2), two DM indicators account for ES. First, the DM indicator, “project timetable” (dec_01), significantly accounts for the variability of ES. Second, the DM indicator, “project targets” (dec_02), significantly accounts for ES. In addition, DM indicators, “project budget” (dec_03), “model of cooperation between the companies” (dec_13), and “information sharing practices” (dec_12) significantly account for ES in the SUPP2 group.

In OEM1, the profit-sharing level significantly accounts for the variability of DM indicators, “technologies to be used” (dec_05), “process models to be used” (dec_06), and “risk identification methods” (dec_09). In the SUPP2 group, more interactions exist. The profit-sharing level is very significant for indicators, “project timetable” (dec_01) and “project targets” (dec_02), and significant for “project budget” (dec_3), ”technologies to be used” (dec_5), ”process models to be used” (dec_6), “risk identification methods” (dec_9), “profit sharing between the companies” (dec_14), and “risk sharing between the companies” (dec_15). These F –tests for interactions are defined in Table 4-11.

Table 4-11. F –test for the interaction of ES and PS and DM

Model							Welch's ANOVA		Significance
Dependent variable	Independent variable	Group	df	SS	MS	R-square	F	Pr>F	
Succ	dec_01	SUPP1	4	73,7842	18.446	0.25054	4.71	0.0088	**
		SUPP2	4	141.304	35.3261	1	Infty	<.0001	***
Succ	dec_02	SUPP1	4	92.6799	23.17	0.3147	4.11	0.0238	*
		SUPP2	4	141.304	35.3261	1	Infty	<.0001	***
Succ	dec_03	SUPP2	4	124.638	31.1594	0.88205	33.65	<.0001	***
Succ	dec_12	SUPP2	3	61.5424	20.5141	0.43553	9.41	0.012	*
Succ	dec_13	SUPP2	3	81.8182	27.2727	0.6	9	0.0007	***
dec_05	h	OEM1	4	14.77941176	3.69485294	0.332341	5.35	0.0356	*
dec_06	h	OEM1	4	15.67941176	3.91985294	0.279843	5.71	0.0245	*
dec_09	h	OEM1	4	17.27647059	4.31911765	0.386193	7.76	0.0134	*
dec_01	h	SUPP2	4	25.65217391	6.41304348	0.64693	23.68	0.0004	***
dec_02	h	SUPP2	4	39.00869565	9.75217391	0.643615	22.45	0.0004	***
dec_03	h	SUPP2	4	33.73333333	8.43333333	0.602381	15.73	0.0023	**
dec_05	h	SUPP2	4	22.647343	5.66183575	0.58265	8.83	0.0066	**
dec_06	h	SUPP2	4	21.66183575	5.41545894	0.582035	8.47	0.0077	**
dec_07	h	SUPP2	4	22.72270531	5.68067633	0.547822	7.25	0.0111	*
dec_09	h	SUPP2	4	15.55748792	3.88937198	0.52009	13.04	0.0024	**
dec_10	h	SUPP2	4	9.56328502	2.39082126	0.486627	7.61	0.0121	*
dec_13	h	SUPP2	4	7.86363636	1.96590909	0.495702	5.91	0.0495	*
dec_14	h	SUPP2	4	23.97424242	5.99356061	0.655197	15.68	0.0022	**
dec_15	h	SUPP2	4	16.59516908	4.14879227	0.658084	12.26	0.0043	**

5. CONCLUSIONS OF THE STUDY

5.1. Performance definition in collaborative software development by collaboration participants

The first research question was defined as "*How is performance defined in collaborative software development by participants of collaboration?"* As a result from the empirical part, definitions for software collaboration success were received as open answers that were further coded and based on which themes were constructed.

The performance of software development collaboration is defined in this study through the themes that were included in the definitions by the respondents. These can be summarized as themes in Table 5-1. Table 5-1 is constructed by combining the results of Tables 4-2 and 4-3. The items what the themes are illustrated to include are taken directly from the open answers. They are descriptive and not attached to any measurement scale as such.

As can be seen, performance definition includes a wide variety of different themes. There is no simple form in which the definition could be constructed. The definition for performance is through themes of relationship, finance, quality, schedule, functionality, relationship volume growth and continuation, supplier flexibility, responsibilities, competence, strategic items, resourcing, people, work planning, and tools and methods.

Table 5-1. Themes included in the definitions of software development collaboration success

Theme	Items included
Relationship related	win-win relationship, communication, trust, co-operation, commitment
Finance, cost and price	competitive price for both companies, long term profitability, keeping the agreed price
Software quality	quality of end result, keeping the agreed quality
Time and schedule	keeping the agreed schedule, deliveries in time
Functionality and requirements	clear and prioritisised requirements, delivering the requirements, providing the agreed functionality
Business volume, growth and continuation	expanding business, repeating business
Suppliers flexibility	scalability, possibility for quick ramp-up, flexibitlity of operations
Ownership and responsibilities	clear interfaces, clear responsibilities, minimum effort from OEM side needed
Competence	high compentence on supplier side, supplier being able to capitalise its competence
Strategic items	suitable strategies in both sides
Resourcing	optimised resource allocations, ability to find suitable resources quickly
People related	"good" people, easy to work with, motivated for the case
Work planning	realistic planning, commitment to planned
Tools and methods	tools and methods used for the work

The definitions of collaboration performance differ between OEMs and supplier companies. The respondents in OEMs and supplier companies prioritize and view the themes differently. The majority of definitions by OEM respondents included time and schedule, price, quality, and relationship-related items while in most of definitions by the supplier group concentrated on relationship-related items and financial items. Time and schedule were less frequently mentioned in supplier groups' definitions. The differences originate from the different viewpoints of the groups. For suppliers, their business is based on the relationships and volume of the received work from OEMs. From the OEM viewpoint, the focus of sourcing activities is more on carrying out the sourced work as planned to be able to deliver software development projects as planned.

The definitions of collaboration performance were found to be different between OEM companies and their suppliers. These differences between the OEM's and the supplier's views on the collaboration performance can be seen natural by comparing their different

roles in the collaboration set-up. OEMs concentrate more on the end products, while supplier companies also consider the relationship sustainability to be important. However, when combining the responses from both OEM companies and suppliers, a wide variety of themes included in the definition of performance was constructed to show the extensity of this term.

5.2. Attributes of profit-, risk-sharing, and sharing of decision-making influencing performance

The third research question was stated as "*What are the attributes of profit sharing, risk sharing and decision-making sharing influencing performance in software development performance?"* Hypotheses were constructed for the relationships between profit sharing, risk sharing, decision-making and experienced collaboration performance in Chapter 2.7. The relationships are summarized in terms of hypotheses.

There were no statistically significant relationship between profit-sharing and experienced collaboration performance. SEM for all the data showed no statistically significant path coefficients between these variables in the model as shown in Figure 4-1 or its equivalent models that are constructed by putting the causalities in other directions. Hypothesis 2, "profit sharing has a positive effect on experienced collaboration success," can therefore be rejected. Profit-sharing is not a predictor of good performance in collaboration cases in this context and should not be deployed in all sourcing cases despite the trends and implications in the literature. This can be seen as the most important finding of this study. This brings an interesting contradiction between the existing research done in the context of parcelled goods manufacturing and software development collaboration.

On the basis of the structural equation model in Figure 4-1, there was no statistically significant influence of profit-sharing on risk-sharing or decision-making. There is no equivalent model that would have illustrated the statistically significant relationship between these variables in other ways. Therefore, hypothesis 3, "profit-sharing has a

positive effect on risk-sharing“, and hypothesis 1, “profit-sharing has a positive effect on sharing of decision-making,” can be rejected at the general level.

SEM model in Figure 4-1 illustrated statistically significant impacts of sharing of decision-making and risk-sharing on the experienced sourcing success. There is no equivalent model that would have illustrated the statistically significant relationship between these variables in other ways. Based on these results, hypothesis 5, “risk-sharing has a positive effect on experienced collaboration success”, and hypothesis 4, “decision-making sharing has a positive effect on experienced collaboration success,” can be accepted at the general level. SEM shows a statistically significant relationship between risk-sharing and decision-making as illustrated in Figure 4-1. It shows that risk-sharing has negative effects on sharing of decision-making. Sharing of decision-making is included in the structural equation model in order to indicate if risk- and profit-sharing has been properly implemented. The assumption behind hypothesis 5 is that risk-sharing has a positive impact on sharing of decision-making. In light of these results, hypothesis 6 is rejected at the general level because of the negative but statistically significant path coefficient. The results discussed can be summarized by collecting the hypotheses and their results at the general level as in Table 5-2.

Table 5-2. The hypotheses and the results of the study

Hypotheses	Description	Deduction
H1	Profit sharing has positive effect on decision making sharing	Rejected
H2	Profit sharing has positive effect on experienced collaboration performance	Rejected
H3	Profit sharing has positive effect on risk sharing	Rejected
H4	Decision-making sharing has positive effect on experienced collaboration performance	Accepted
H5	Risk sharing has positive effect on experienced collaboration performance	Accepted
H6	Decision-making sharing has positive effect on risk sharing	Rejected

5.3. Differences in attribute influences by collaborator roles

The third research question was defined as “*does the collaborator role change the influences of attributes of profit sharing, risk sharing and decision-making sharing to collaboration performance?”* This was analyzed by MANOVA.

The analysis shows that there are no differences between the collaboration roles in the influences of profit-sharing attributes on collaboration performance. In any collaboration roles, profit-sharing did not show influence on the collaboration performance.

Differences were found between the collaborator roles in influences of attributes of risk-sharing and sharing of decision-making on collaboration performance. Inside OEM groups (OEM1, OEM2), there was no risk-sharing indicator that would significantly account for experienced sourcing success. Inside supplier groups (SUPP1 and SUPP2), there were specific risk-sharing attributes that significantly accounted for experienced sourcing success. The differences in the implications of the risk sharing attributes by collaborator types can be connected with the different definitions the collaborator types have for collaboration performance. When the collaboration performance is defined differently, risk-sharing attributes have different influence on it. The risk-sharing attributes influencing collaboration performance were different also between the two supplier groups. This can be explained on the basis of the different history of implementing risk-sharing in the interorganizational relationship, as well as the different software development projects.

The influence of the attributes of sharing of decision-making on collaboration performance is scattered across the respondent groups. Significant relationships were found only inside OEM1 and SUPP2 groups. This could be said to be connected to the different histories of implementing risk-sharing in the interorganizational relationships as well as the different collaborator types. The sharing of decision-making was assumed in this study as the instantiation of implementation of profit- and risk-sharing. It was also known beforehand that OEM2 was having more experiences of agreements with profit- and risk-sharing with the suppliers. SUPP2 group could therefore be strongest group for experiencing the implications of sharing of decision-making in practice. OEM1 had not much deployed profit- and risk-sharing with its suppliers, but still the influences of the general items such as technologies and processes used were shown inside this group.

6. DISCUSSION

6.1. Contributions of this study

The present study provides insights into the collaboration performance in software development in the telecommunications domain. It is also one of the very few examples in the literature in which software development collaboration in telecommunication industry has been studied empirically and examined systematically. Furthermore, evidence was found to show differences between the existing research on profit-sharing implications in context of parcelled goods manufacturing and profit-sharing implications in software development.

The contributions of this study are divided in this chapter into contributions to theory and managerial contributions. First, the contributions to theory are discussed. As a main contribution, this study examined the existing research gap of attributes of profit- and risk-sharing implications on collaboration performance in software development and provides their results that differ from the existing research on such implications in other contexts. Also, by bringing new information into the research gap, this study also necessitates the need for further studies by addressing further questions.

The study contributes to the research and discussion on collaboration performance by defining it in a very specific context. Also, contributions are made to discussion on interorganizational relationships as the definition of performance is different in the two roles—OEM and supplier.

In the concept analysis, the inconsistent terminology related to different interorganizational relationship types was analyzed and the usage of concepts was defined for this study from the viewpoint of profit- and risk-sharing in the relationship. The concept analysis and concept definitions contribute to the discussions on different interorganizational relationship types and their differences.

As a managerial contribution, the aspects of this study that can be exploited in practical business life are discussed. First, this study contributes to practice by defining the collaboration performance as a concept that consists of wide variety of different themes. When considered as a broad concept, the definition of performance helps in finding new avenues for improving the collaboration performance in practice. It provides a better understanding of the differences in how OEMs and suppliers view sourcing performance, and helps both sides in building a better relationship.

The discussion and viewpoint of partnership superiority over other types of interorganizational relationships has been very obvious in the industry. This study contributes to this area by providing statistically confirmed, objectively and systematically derived research results on the implications of profit- and risk-sharing, which help the management to take a fresh look at the benefits of different relationship types and make the best choices in their collaboration cases.

6.2. Assessment of the study

6.2.1. Reliability of the study

The quality of the research results can be identified by the reliability and validity of the results. Although reliability and validity are discussed separately, they are not independent of each other. Reliability can be seen as a condition for validity (McDonald, 2005).

Reliability can be defined as "the extent to which an experiment, test or any measuring procedure yields the same results on repeated trials" (Carmines and Woods, 2005a, p. 361). More simply, it is the measure of the repeatability of the results to determine if the results are the same if some other researcher repeats the same research or if the same respondent participates in research several times (Hirsjärvi et al., 1997). Reliability assessment includes the assessment of the random error and estimates its consequences in research (Carmines and Woods, 2005b). Researchers are advised not to only focus on eliminating the random error but on detecting the existence of its impact (Carmines and

Woods, 2005a). The reliability of this study can be evaluated for the research process, questionnaire data, and the measures that were used.

First, the reliability of the research process is analyzed in the sequence of research problems, discussing how the results for each research problems were obtained. For first research question, the definition of collaboration performance was obtained from the open answers. Coding of the themes was conducted twice as advised by Eskola and Suoranta (1999). The reliability of this analysis can be concluded to be adequate. For the second research question, the profit-sharing levels in use were analyzed simply by calculating the amount every level was chosen. Also this phase was done twice to enhance the reliability.

For the second and third research questions, SEM and MANOVA analyses were used. Typical problems for the reliability in SEM come from the existence of equivalent models. It has been emphasized that for the quality of the research, the existence of equivalent models must be recognized and analyzed, and in the end eliminated. If not recognized, the equivalent models affect the plausibility of the findings by limitations or making them flawed (e.g., related to causal relationships). During the construction of the model, the aspect of equivalent models was recognized. The five-step plan for addressing equivalent models in SEM research proposed by Henley et al. (2006) was followed. Equivalent model was found and excluded on the basis of the construction of the variables in this study and MANOVA results.

Improper solutions can be considered as another problem for reliability in SEM. Sampling fluctuations, model misspecification, underidentification of the model, empirical underidentification, and outliers/influential cases are the reasons for improper solutions. Researchers are advised not to use negative error variance estimates as an indicator of the model misspecification or lack of improper solutions as a support for the model structure (Chen et al., 2001) Improper solutions are found more common in small samples than in large ones. Negative error variance estimates are not used as a model misspecification indicator in this study, and the model structure is not supported by the lack of improper solutions.

During the structural equation model construction, some error covariances were set free to improve modification indices. This is discussed in Landis et al. (2000) and not supported because of the decreased degrees of freedom for the model (Karjaluoto and Juntunen, 2007). However, the procedure was seen reasonable to be implemented in this study between the indicators loading for the same latent variable because the degrees of freedom were still sufficient, and it has been done in other SEM analyses in this field (e.g., Aramand, 2007).The reliability of the research process can be concluded to be adequate. It is highly presumable that another researcher would obtain the same results for these research problems when using the same research process with the same data.

The reliability of research data is discussed next. The data collected is more of a snapshot of the industry at a given time instead of a long-term comprehensive study. For example, the economy recession during the time of finishing this study might have an effect on the answers. The reliability of the data was strengthened by allowing respondents to give their responses anonymously. Because the respondents were chosen carefully, it can be anticipated that the respondents understood the choices correctly and gave the right information. Also, the questionnaire was tested before conducting the survey as recommended by Czaja and Blair (2005). The reliability in the success determination was strengthened by replicating the measure during the occasion as advised by Alwin (2005). In addition to the open question on the sourcing success definition, the reasons why the respondent identified the cases as most successful and most unsuccessful are used to supplement the definition of sourcing success. The reliability of the research data can be considered adequate. It is highly presumable that another researcher would have obtained the same data by using same respondents.

Last, the reliability of measures is discussed. Reliability of measures can be estimated by one of the four ways that are proposed e.g. by Garson (2009b) and Metsämuuronen (2003). These ways are (1) internal consistency, (2) split-half reliability, (3) test–retest reliability, and (4) inter-rater reliability. Internal consistency is estimated on the basis of the correlation among the variables comprising the set, and was chosen to be used in this study. The value of Cronbach's alpha was used to estimate the internal consistency. Already tested constructs should be used instead of creating new ones (e.g., Karjaluoto and Juntunen, 2007). In this study, new measure constructs that are more specific for the context of the study were created, and this brought weaknesses for the measure

constructs. Some of the measures received lower values than the proposed limits for Cronbach's alpha, and these measures were dropped out from the further analysis. All the remaining measures had values of Cronbach's alpha above the proposed limits and for these measures, the internal consistency and thereby reliability of measures can be considered adequate.

6.2.2. Validity of the study

The validity of the research is estimating whether the research is studying the phenomenon the researcher is arguing it to be studying. The validity of the research measures the ability of the research to measure the phenomenon in question exactly. While reliability is related to random errors, validity is related to nonrandom errors (Carmines and Woods, 2005c). Validity can be classified as internal and external validities. External validity refers to the extent to which the research can be generalized. Internal validity can further be divided into content validity, construct validity, and criterion-oriented validity (Metsämuuronen, 2003; McDonald, 2005). The validity of this study is analyzed here through these concepts of validity.

First, the internal validity of this study is discussed through content validity, construct validity, and criterion-oriented validity. Content validity refers to the extent to which measures used in the study are in accordance with theory, are operationalized correctly, and encompass the phenomenon in question broadly enough (Metsämuuronen, 2003). McDonald (2005) identified linkages between theory and practice in four levels: concept (an abstract object or thought), concept definition (a concept put into words), operational definition (classification rules for the concept definition), and scoring (data gathering for a measure following the rules defined in the operational definition). The content validity of this study can be assessed through these levels. The measures were derived from the existing theory, and the measurement in the questionnaire used the terms used in practice as much as possible in order to strengthen the validity of the study. The phenomenon was measured as the experiences of the respondents. Because of the reliability of the results, some decision-making items and risk items are dropped from the analysis that lower the validity of the research results by restricting the

possibility to encompass the phenomenon in question as broadly as planned, but these problems affect only on single parts of the measurements.

Construct validity estimates if each of the items that are used in the study is really measuring the latent variable behind the variables (Carmines and Woods, 2005c). The items belonging to the same latent variable should be correlated more systematically with each other than with the items in other latent variables (Metsämuuronen, 2003). Confirmatory factor analysis shows that the items belonging to latent variables, risk- and decision-making, have adequate correlation with the other items belonging to the same latent variable.

For analyzing criterion-oriented validity, which is further described as concurrent validity or predictive validity, the value of the measure is compared to a value operating as a criterion for the validity. The often used measurement for analysing criterion-oriented validity is the correlation coefficient (Metsämuuronen, 2003). The correlation coefficient for the measurements was calculated. Constructs of seven risk-sharing items and two sharing of decision-making items were identified to have too low correlation value (<0.6) and they were removed from the further analysis.

The evaluation of external validity is discussed by the extent to which research can be generalized. The data collected was more of a snapshot of the industry at a given time, and the results cannot be fully generalized in to the different periods of time. The companies participating into the survey represented well the typical telecommunication industry OEM and supplier companies, and the results can be seen to be able to be generalized for software development in telecommunications industry.

The importance of taking the threads for research validity into account beforehand the research is carried out was emphasized by Cook and Campbell (1979) as the most important aspect for the research validity. The validity threads were taken into account when designing the survey and its questions. Also, triangulation of the research methods was used to increase the validity of our research (Hirsjärvi et al., 1997).

From the viewpoints of internal and external validity, the research design took the validity into account in research methods and data sampling. During the research

process, measurements showing low validity were removed from the further analysis. Therefore, the validity of this study can be considered adequate.

6.2.3. Limitations of this study

As discussed earlier, the measure constructs in the questionnaire were defined from the literature review in this study and have not been tested before. During the evaluation of the measure constructs, some reliability and validity problems were found in some decision-making items and risk items, and these were dropped from the analysis. This brings some limitations by reducing the items included in the study. A better choice would have been to use some existing measure constructs for the items. Using a measure construct designed for some other contexts would also impose limitations. Measure constructs include two measures, experienced success and the highest profit sharing level used in the case, measured as single items. These are assumed to be measured without error. The experience of success is measured by choosing the two extreme cases where the respondent participated, and the chosen respondents know well the profit-sharing level that was used in the case in question.

In the study, the scope of decision-making sharing was limited. It was considered as an instantiation showing the level of profit-sharing and risk-sharing deployment. It was not raised up into the same level as profit- and risk-sharing in operationalization or concept analysis. If done so, the scope of this research would have been much wider as the sharing of decision-making itself is a wide concept, which could be seen by oneself as an item of this kind of study. The limitation of this study is that the defined role of sharing of decision-making imposes limitations on the whole study as all the implications of it are not considered.

Response rates varied among the respondent groups, and in some groups the response rate was low. During the data collection phase, to decrease this difference, the number of invitees was grown. The response rate was lowest in OEM1, even when the number of invitees grew by the time new contact persons were found to increase the number of respondents. However, the number of possible invitees was limited because of the

criterion set for the respondents. The reason for this could be the timing of the questionnaire, since many other questionnaires were ongoing at the time in OEM1, and people were not too enthusiastic to take part in this "optional" questionnaire. The length of the questionnaire caused some respondents to discontinue answering at some point.

Literature shows the low response rates are a general problem. Still, with low response rates acceptable results have been achieved. Mohr and Spekman (1994) achieved a response rate of 35% that they considered as acceptable and consistent with the rate found in other studies. A bit lower response rate, 21%, was achieved by Simatupang and Sridharan (2005) with 76 completed questionnaires from 367 represented samples. This response rate was considered to be adequate when the survey length and the high level of managers that were targeted were taken into account. An even lower response rate of 15.1% was received by Corsten and Felde (2005) for their email questionnaire, even with reminders and follow-up emails and phone calls. The sample of this study can be seen presentable, and the response rate is in line with other research in this area. Therefore, the response rate can be seen acceptable.

To analyze the *nonresponded bias* for this study, it was found that, people who did not respond were more from R&D departments than from departments of sourcing or sales. It is logical to assume that as the questionnaire was named as the questionnaire for studying profit-sharing implications, it was found to be more interesting by the sourcing and sales people. For people working in R&D departments, these items might have seemed more distant. However, the criteria set for the respondents were fulfilled, and there were responses from R&D departments; therefore, the non-responded bias can be considered adequate for the results.

Sample sizes varied among different respondent groups. The sample size of N=119 was achieved by separating the answers of the most successful cases and the most unsuccessful cases, and treating them as individual cases. This was consistent with the answers because the answers of most successful and most unsuccessful cases were not dependent on each other. The number of respondents was 61, which can be considered adequate. It has been proposed that the sample should include at least 30 to be able to make generalizations in qualitative research (Koskinen et al., 2005). For this study, this limit of samples was achieved in both OEM and supplier groups.

For quantitative methods, suggested sample sizes are typically quite high. Sample sizes of 150 (Anderson and Gerbing, 1988) and 200 (Kelloway ,1998; Garson, 2008) are suggested. At the same time, there are studies conducted with significantly lower sample sizes and still found adequate. For example, structural equation modelling was carried out with the sample size of 52 (Aramand, 2006), and statistical analysis was conducted with sample size of 53 (Cassivi, 2006) and 55 (Min et al., 2005).

The needed sample size depends on several factors, which the researcher cannot define beforehand, and does not depend on the size of the universe to be sampled, as suggested by Garson (2002). The following rules for the sample size are defined by Garson (2002):

1. The smaller the effect the researcher is trying to prove, the larger the sample must be.
2. The more variables used by the researcher as controls on an effect, the larger the sample must be.
3. The more unequal to distribution of values of variables examined by the researcher, the larger the sample must be.
4. The statistical methods to be used may also influence the number of cases needed.

When considering the rules of Garson (2002) and Karjalainen et al. (2005), and comparing the sample size with those in previous studies, the sample size in this study can be considered adequate. The sample size represents a limitation, but it is balanced by the quality of the respondents and their experience.

Interpretations made by the researcher always affect the results. This was taken into account when the definition of collaboration performance was constructed by forming groups and finding themes in the responses. Coding was done twice to decrease the errors and the effects of interpretations.

Interpretations made by the respondents can also affect the results of the data sampling. As discussed by Gummesson (1993), there is always a possibility that the respondents understand the questions differently, they do not have enough knowledge to answer the

question but they still do, and they have personal attitudes that affect the results. In this case, the respondents were asked of their experiences. Therefore, how respondents remember the situations can impose limitations on the study. The experiences can be also biased. These challenges were taken into account when conducting the study with different expedients; the respondents were chosen carefully against the criteria, the questionnaire was tested before collecting the actual data, the experiences were collected on the most successful and most successful cases the respondent had participated, and the terminology was kept as close to the practical items as possible in the operationalisation of the measurement.

6.3. Recommendations for further studies

The differences between the response groups constitute an interesting field for further studies. How the experiences differ between the companies with different usages of different collaboration models, and how they differ between the companies in OEM and supplier roles should be studied in more detail. Considering the differences and analyzing them in more detail with larger sample sizes would facilitate acquisition of new valuable information on how profit-sharing affects risk-sharing, sharing of decision-making, and experienced success.

A longitudinal study on the sample included in this study could be considered a further study. The sample used in this study was collected in the first half of 2008 when the global economic situation was considered to be rather good. After the data collection, the global economy went into a recession, and the telecommunications industry has been forced to undertake a fierce cost-cutting. As OEMs cut their costs in sourcing and R&D activities, the suppliers were forced to cut their costs and their business decreased. It would be interesting to study how these circumstances affect the respondents' experiences in profit-, risk-sharing, sharing of decision-making, and sourcing success.

The list of items included in this study as the factors of performance are limited to risk-sharing, decision-making, and profit-sharing. Identification of other items affecting the performance in this context could be an area for further study as this study shows that the results achieved in the context of parcelled goods manufacturing cannot be

generalized into the software development. This could further be researched as case studies of most successful and most unsuccessful collaboration cases. The reasons why profit-sharing does not affect the experienced success should also be further studied more deeply. Also, as sharing of decision-making was limited in this study, the implications of sharing of decision-making on collaboration performance in a similar context should be studied further.

The contractual side of risk- and profit-sharing in software sourcing was beyond the scope of this study. However, it will be a critical factor for making the relationship to perform well. It would be interesting to find the contractual issues that are used in other industries when risks and profits are shared, and to find out if they could be adopted in software development in the telecommunications industry.

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APPENDIX 1: Cover letter and questionnaire form

Format of the questionnaire is not one-to-one with the original one; the graphical user interface of the questionnaire is not included here

Dear recipient,

I have a hobby of writing a dissertiation study in Tampere University of Technology on risk and profit sharing and its effects on success met in software sourcing in the telecommunications industry. For this study I am conducting a survey about the aforementioned issues among different companies, and I would greatly appreciate if you could share your opinions and experiences on these topics. The results will be handled anonymously. Any confidential information about your company, or personal information will not be published.

Answering the survey takes approximately 15 minutes, and the survey is available from (link to www questionnaire)

In return for your efforts, I will provide the results of the study for all of you who are interested, once the results have been analysed and ready to be published (during 1H 2008). There will also be a lottery of Delicard gift voucher among the participants. If you want to partake in the lottery or get a summary of the results, please include your contact information at the end of the questionnaire.

Feel free to forward this email to others that could also be interested in taking part in the survey.

If you have any questions, please do not hesitate to contact me!

Br,
Hanna Pihlajarinne
hanna.pihlajarinne@tut.fi

Survey questionnaire

Welcome to give your opinions on collaboration success, and profit and risk sharing!

The results of this survey will be used in a dissertation study that I am writing in Tampere University of Technology. The results will be handled anonymously. Any confidential information about your company, or personal information will not be published.

There will be a lottery among the survey participants. If you want to partake in the lottery, please include your contact information at the end of the survey. This information will only be used for lottery purposes. The winner is contacted personally. All persons including their names and contact information will also receive the results of the study when they have been analysed and ready to be published (during 1H 2008).

If you have any questions, please do not hesitate to contact me!

Br,

Hanna Pihlajarinne
hanna.pihlajarinne@tut.fi

1. BACKGROUND INFORMATION

1. What is your role when collaborating with other companies?
2. How long have you been working in this role?
3. How would you determine success in software sourcing?
   Which factors does it consist of:
   - time
   - quality
   - functionality
   - communication between companies
   - price

□ trust between companies

□ something else, what?

2. MOST SUCCESSFUL COLLABORATION YOU HAVE PARTICIPATED IN

In your mind, choose the collaboration that you consider to be the most successful. For the following questions, answer from the point of view of the collaboration efforts.

4. How long a collaboration history you have had with this company?
5. What kind of collaboration model did you have with this company?

   □ Collaborator is paid by work done in units of working hours

   □ Collaborator is paid by fixed, contracted price

   □ Collaborator is paid by fixed, contracted price and in addition some extra payments on separately agreed criteria (quality, schedule, etc.)

   What was the criterion?

   □ Part of payment for the collaborator is tied to product sales

   How this has been done?

   □ Collaborator is paid by share of the profits in the same manner that it has been taking risks for the product

   □ Some other model, what?

6. How satisfied were you with that collaboration model?
7. Would you be interested to change your collaboration model to some other model listed above? Which one? Why?
8. How happy were you with the visibility you had for this company's current situation and future plans?
9. Was there something you would like to know more about concerning them?
10. Why did you choose this company for collaboration?
11. How did you decide the collaboration model?
12. What was the software development process model/methods that you used for developing this product

    □ waterfall model

□ incremental software development

□ iterative software development

□ agile software development,

□ lean software development

13. Which parts of the process you were responsible of?
14. Which parts of the process the collaboration partner was responsible of?

COLLABORATION RESPONSIBILITIES AND RISKS FOR YOUR COMPANY

15. How would you evaluate your company's contribution and ability to affect the decisions related to this collaboration on a scale of 1-5, where

    1= our company decided

    2= our company decided, but also some contribution from the other company

    3= both companies decided together

    4= collaboration partner decided, but also some contribution from us

    5= collaboration partner decided

    in matters of

Project timetable	1 2 3 4 5
Project targets	1 2 3 4 5
Project budget	1 2 3 4 5
Personnel to be used in the project	1 2 3 4 5
Technologies to be used	1 2 3 4 5
Process models to be used	1 2 3 4 5
Tools to be used	1 2 3 4 5
Knowledge development of collaboration company's personnel	1 2 3 4 5
Risk identification methods	1 2 3 4 5
Risk prevention practices	1 2 3 4 5
Plans in case of risk realization	1 2 3 4 5
Information sharing practices	1 2 3 4 5
Model of co-operation between the companies	1 2 3 4 5
Profit sharing between the companies	1 2 3 4 5
Risk sharing between the companies	1 2 3 4 5
Criteria of extra payments (if existing)	1 2 3 4 5

16. What risks do you see your company and the collaboration company have in this collaboration on a scale of 1-5, where

1= our company has all the risk
2= our company has most of the risk, but also some risk for the other company
3= the risk is divided evenly between the companies
4= collaboration partner has most of the risk, but also some risk for us
5= collaboration partner has all the risk

Product related risks

Developing a wrong kind of user interface	1	2	3	4	5
Developing wrong functionality	1	2	3	4	5
Product not meeting requirements	1	2	3	4	5
Performance problems	1	2	3	4	5
Technical problems in product	1	2	3	4	5
"Gold –plating"; building fancy UI etc. at the cost of functionality and features	1	2	3	4	5
Risk to fail maintaining the product	1	2	3	4	5
Risk not to be able to enhance the product as planned	1	2	3	4	5

Project related risks

Cost overruns	1	2	3	4	5
Schedule slippages	1	2	3	4	5
Work amount estimation failure	1	2	3	4	5
Need for doing rework	1	2	3	4	5

Organisation related risks

Collaboration contract cancellation	1	2	3	4	5
Problems in collaboration contracts and litigations	1	2	3	4	5
Lack of competent personnel	1	2	3	4	5
Incorrect resource usage	1	2	3	4	5
Personnel management risks	1	2	3	4	5
Competition inside teams	1	2	3	4	5
Problems in trust and values	1	2	3	4	5
Company barriers preventing natural interaction between software designers	1	2	3	4	5

Process model related risk

Over-promising software capability in the contract before everything is understood	1 2 3 4 5
Introducing too many new features to the product during development, and building a project that is too complex and large	1 2 3 4 5

Strategic risks

Business failure	1 2 3 4 5
Loss of business credibility	1 2 3 4 5
Litigations	1 2 3 4 5
Issues that tarnish company image	1 2 3 4 5
Loss of revenue	1 2 3 4 5

COLLABORATION FORTUNES

17. Why did you identify this collaboration as most successful? What was the most important factor that was affecting this choice?
18. Do you see that the profit and risk sharing between the companies affected the successful result?
19. Do you see that some other profit and risk sharing model increased or decreased the successful result?
20. Any other comments?

3. MOST UNSUCCESSFUL COLLABORATION YOU HAVE PARTICIPATED IN

In your mind, choose the collaboration that you consider to be the most unsuccessful. For the following questions, answer from the point of view of the collaboration efforts.

21. How long a collaboration history you have had with this company?
22. What kind of collaboration model did you have with this company?

□ Collaborator is paid by work done in units of working hours

□ Collaborator is paid by fixed, contracted price

□ Collaborator is paid by fixed, contracted price and in addition some extra payments on separately agreed criteria (quality, schedule, etc.)

What was the criterion?

□ Part of payment for the collaborator is tied to product sales

How this has been done?

□ Collaborator is paid by share of the profits in the same manner that it has been taking risks for the product

□ Some other model, what?

23. How satisfied were you with that collaboration model?
24. Would you be interested to change your collaboration model to some other model listed above? Which one? Why?
25. How happy were you with the visibility you had for this company's current situation and future plans?
26. Was there something you would like to know more about concerning them?
27. Why did you choose this company for collaboration?
28. How did you decide the collaboration model?
29. What was the software development process model that you used for developing this product waterfall model

□ incremental software development

□ iterative software development

□ agile software development,

□ lean software development

30. Which parts of the process you were responsible of?
31. Which parts of the process the collaboration partner was responsible of?

COLLABORATION RESPONSIBILITIES AND RISKS FOR YOUR COMPANY

32. How would you evaluate your company's contribution and ability to affect the decisions related to this collaboration on a scale of 1-5, where

1= our company decided

2= our company decided, but also some contribution from the other company

3= both companies decided together

4= collaboration partner decided, but also some contribution from us

5= collaboration partner decided

in matters of

Project timetable	1 2 3 4 5
Project targets	1 2 3 4 5
Project budget	1 2 3 4 5
Personnel to be used in the project	1 2 3 4 5
Technologies to be used	1 2 3 4 5
Process models to be used	1 2 3 4 5
Tools to be used	1 2 3 4 5
Knowledge development of collaboration company's personnel	1 2 3 4 5
Risk identification methods	1 2 3 4 5
Risk prevention practices	1 2 3 4 5
Plans in case of risk realization	1 2 3 4 5
Information sharing practices	1 2 3 4 5
Model of co-operation between the companies	1 2 3 4 5
Profit sharing between the companies	1 2 3 4 5
Risk sharing between the companies	1 2 3 4 5
Criteria of extra payments (if existing)	1 2 3 4 5

33. What risks do you see your company and collaboration company have in this collaboration in scale 1-5, where

1= our company has all the risk

2= our company has most of the risk but also some risk for the other company

3=the risk is divided evenly between the companies

4= collaboration partner has most of the risk but also some risk for us

5= collaboration partner has all the risk

Product related risks

Developing a wrong kind of user interface	1 2 3 4 5
Developing wrong functionality	1 2 3 4 5
Product not meeting requirements	1 2 3 4 5
Performance problems	1 2 3 4 5
Technical problems in product	1 2 3 4 5
"Gold –plating"; building fancy UI etc.at the cost of functionality and features	1 2 3 4 5
Risk to fail maintaining the product	1 2 3 4 5
Risk not to be able to enhance the product as planned	1 2 3 4 5

Project related risks

Cost overruns	1 2 3 4 5
Schedule slippages	1 2 3 4 5
Work amount estimation failure	1 2 3 4 5
Need for doing rework	1 2 3 4 5

Organisation related risks

Collaboration contract cancellation	1 2 3 4 5
Problems in collaboration contracts and litigations	1 2 3 4 5
Lack of competent personnel	1 2 3 4 5
Incorrect resource usage	1 2 3 4 5
Personnel management risks	1 2 3 4 5
Competition inside teams	1 2 3 4 5
Problems in trust and values	1 2 3 4 5
Company barriers preventing natural interaction between software designers	1 2 3 4 5

Process model related risk

Over-promising software capability in the contract before everything is understood	1 2 3 4 5
Introducing too many new features to the product during development, and building a project that is too complex and large	1 2 3 4 5

Strategic risks

Business failure	1 2 3 4 5
Loss of business credibility	1 2 3 4 5
Litigations	1 2 3 4 5

Issues that tarnish company image	1 2 3 4 5
Loss of revenue	1 2 3 4 5

COLLABORATION FORTUNES

34. Why did you identify this collaboration as most unsuccessful? What was the most important factor that was affecting this choice?
35. Do you see that the profit and risk sharing between the companies affected the unsuccessful result?
36. Do you see that some other profit and risk sharing model increased or decreased the unsuccessful result?
37. Any other comments?
38. Any comments relating to this questionnaire or its topics?

Thank you for your participation!

If you want to partake in the lottery, please add your name and contact information here.

Name:

Address:

Email:

APPENDIX 2: Quotations from answers into open questions

OEM 1 responses

How would you determine success in software sourcing?

1. Developed SW meets requirements, has acceptable qulaity, delivered in time and in competitive price
2. Success is timely availability of the right deliverables with win-win business for both parties
3. .suprisingly well
4. Repeatable delivery in an agreed schedule, in agreed quality and for a agreed price
5. Yes
6. The result is cheaper and/or quicker than inhouse
7. Quality and Finance met.
8. High quality results with right level of investment.
9. Cost efficient on-time deliverables on required or higher quality.
10. Varying from project to project and company to company. Generally, feedback from internal customers has been good.
11. Success is based on long-term business relationships which enables better cooperation and development of different issues and processes between partners.
12. Getting what was required in required quality, time and money.
13. timely delivery, good quality, clear responsibility of error correction and maintenance, open and frequent communication of issues and progress
14. Big and complicated tasks seem to be hard to subcontract, typically huge delays to get project ready. For small tasks (~few months) and temporary labour subcontracting works fine.
15. Just fine. Risk and reward should have bigger role, but it has been good so far... Wed, 1/23/08 12:59 PM
16. High quality work results, with minimum effort from me, and with reasonable costs.
17. A win-win where both parties benefit in time-to-market, quality, more "WOW", green&soft values and profit.
18. Reliable company, which keeps its promises, and listens to the requirements
19. (empty)
20. Evaluate planned versus completed work in project level. Evaluate the total cost a) if the work is done by subcontractor versus b) the work is done by Nokia.
21. Overall it has been successful.
22. (empty)
23. The end result is meeting the requirements and delivered in time with good quality. Professional way of working including e.g. that collaboration does not take too much effort, inbuilt quality exists, tools and methods are used enable efficient work. In addition collaboration should back

the existing strategy and ideally collaboration should drive also whole industry to selected direction.

24. Delivers according to plans:: features in time and costs

MOST SUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most successful? What was the most important factor that was affecting this choice?

1. Good technology, error free code
2. A long relation ship
3. Don't know the reason. Probably the only option available then
4. Choice given on proprietary. Proprietary product
5. Trust
6. It was the only one I have been part of
7. Suppliers quality, flexibility and price.
8. Was ramped-up quickly in an abroad site, has had a relatively successful history.
9. Delivery was on time, project stayed in budget,
10. Quality was very good, documentation and competence transfer after project was done.
11. Successful long-term relationship, and if some challenges or problems occurred they could be discussed openly and the solution to them could be agreed upon easily. Open and flexible communication.
12. Long, good cooperation. Success with various components.
13. Timely delivery, simple and clear task & deliverable. Clearly specified task which did not require countless iteration rounds. Clear lump sum pricing.
14. They are flexible
15. Flexibility via good relationship
16. Successful recruitment history
17. The collaborator was flexible to our needs and was able to deliver results according to our requirements.
18. Ability to find needed resources quickly. And after a long partnership, the company understands our needs and requirements, so the resources are almost always perfect for our needs.
19. It is easy to coordinate and communicate when the project team is working together in the same premises.
20. Strategic reasons
21. High competence level
1. If risk occurs, both parties suffer.

MOST UNSUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most unsuccessful? What was the most important factor that was affecting this choice?

1. High price after all
2. Cost
3. It was the only one I've been involved in
4. Suggestion of changes in contract and trying to invoice all small extra work.
5. They were not able to deliver what has been ordered. They didn't communicate it to us early enough.
6. Problems could not be effectively solved, even though there were lots of meetings and communication. It seemed that the collaboration company was not committed to the case and business relationship after all.
7. We did not get what we ordered.
8. schedule slippage, lots of errors, functionality problems
9. They had a lack of experience, they promised too much for us. Project was started as a black box and we noticed too late problems. Delay was 1.5 year.
10. lack of competence & effort estimation problems
11. Unskilled people
12. No results were achieved.
13. It is difficult to define the project as fixed price project. The cost overruns happen easily.
14. Schedule and content of deliveries continuously not met, non-working quality control in collaboration company, no professional way working with attitude to deliver productized quality releases.

OEM2 responses

How would you determine success in software sourcing?

1. There has to be good level of understanding between the parties and competence on the supplier side is a must
2. Successful sourcing means good understanding of the sourced work, keeping the schedules and providing the defined functionality
3. Success depends on various factors both quantitative and qualitative (e.g. quality, schedule, trust, long term relationship)
4. Being able to get extra value (lower cost, broader functionality, development speed, flexibility) for your business by using external partner.
5. It should fully support to company's goals/objectives. The company should also get added value e.g. from subcontracting.

6. Win-win
7. Being able to provide lower costs in addition to flexibility (ramp-up/down) for projects - while keeping planned schedules and quality.

MOST SUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most successful? What was the most important factor that was affecting this choice?

1. The collaboration case was rather well defined and also the revenue potential (cost saving) was remarkable
2. Flexibility, commitment and results from the collaborator.
3. Getting complex product out to the market and supporting business with them.
4. Many of the projects have successfully gone through with this collaborator. The most important factors: Price, competence, flexibility, schedules of the projects, quality of the SW.
5. Not too many competitors in their area, improving performance lately.
6. Long co-operation and lots of focus from both sides - we are their nr 1 customer and they are our nr 1 partner (for my unit)

MOST UNSUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most unsuccessful? What was the most important factor that was affecting this choice?

1. Significant delays in implementation. lack of good requirement definition
2. Projects didn't achieve the targets. (Schedules, SW quality, prices, competence)
3. The company has had too high expectations on the co-operation with Nokia/NSN. Also their recent internal organizational changes have been unsuccessful.
4. Biggest loss for termination - money thrown out the window

OEM 1 suppliers

How would you determine success in software sourcing?

1. Project continuation is the main indicator of success. If the customer wants to prolong the contract, then the subcontractor has succeeded.
2. Ability to fulfill business requirements. Ability to scale the service. Joint impact in the market

3. SW is not the main focus area, success is moderate
4. Success is reached, when the customer is turning back to supplier in order to extend cooperation and on top of that is becoming our sales force - giving positive references to potential customers
5. When supplier and sourcing company both have a win-win situation. Trust is formed between the two companies and information flow without barriers.
6. Criteria for sourcing have to be clear and prioritized
7. When the objectives are met and those objectives aim for a win-win scenario for both parties. That makes it a sustainable in the long term.
8. cost performance, quality control, delivery
9. good and fluent co-operation in projects, good communication and understanding between partners, trust between partners
10. Two main issues: customer satisfaction, supplier satisfaction. Behind those there are lots of issues. Some to mention: - financial win-win - delivery content and schedule - communication - all-over flexibility
11. Open communication
12. From supplier point if view: - Increased revenue over long-term period (eg 2-3 year period) - healthy (~15%) margin from the account
13. . Transparency and mutuality vis-à-vis communication, requirements, future aspirations.
14. You have been successful with local customer and have fully operational offshore capabilities.
15. In recent years, Software outsourcing business develops rapidly.

MOST SUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most successful? What was the most important factor that was affecting this choice?

1. Feedback from the customer. Also we have heard that our customer has recommended us to other buyers inside their company.
2. Increase of cooperation volume, scope and effectiveness
3. Open Communication and trust building.
4. Communication on potential risks
5. We could provide our personnel both off-site work and on-site work so that we could needed collect information. Having often communication with one and other was one of the keys to the success.
6. It has been working very well, trust, understanding, same values
7. Bold attitude to take new models and processes in use. Project success.
8. The co-operation has worked extremely fine Mon
9. The value chain position it gave our company in the business environment
10. can't disclose
11. The partners outsourcing business cooperation strategy

MOST UNSUCCESSFULL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most unsuccessful? What was the most important factor that was affecting this choice?

1. The customer was dissatisfied and didn't want to continue. This project also harmed the company's image (my former employer) inside the buyer organization and that is crucial for a subcontractor.
2. Hard to motive people and concentrate on goals if you don't participate in setting up of those. Very low influence for the project goals and way of reaching them. The whole set-up is rather not the real partnership and collaboration - it's just execution.
3. Lack of trust. Risks were not identified early on and then were disguised until too late
4. Our resources in unsuccessful customer-lead project. We had no chance to control or affect to whole - one or couple of resources had a null impact to whole.
5. The company is too big. They were not able to work we and our customer wanted
6. No Win-win business model

OEM2 suppliers

How would you determine success in software sourcing?

Right people in right place. Sufficient competence, good motivation, realistic promises and keeping of those. Good quality. Mon, 4/21/08 8:38 AM

2. - Low cost with good quality for the customer - Repeat business/expansion of business for the supplier Fri, 4/18/08 8:34 AM

3. Timely delivery of working product to the end customer resulting into profitable business for supplier and customer. Wed, 4/16/08 9:15 PM

4. It used to work very well, but as the sourcing has moved from cooperation to pure cost/price cutting it has suffered significantly. Tue, 4/15/08 11:54 AM

5. Customer value and benefit, adequate/agreed quality, profitability for supplier Tue, 4/15/08 10:25 AM

6. "customer can sleep well coming years" Mon, 4/14/08 3:14 PM

7. Trusting and close relationship that enables strategic partnership Mon, 4/14/08 11:44 AM

8. Customer gets, what he/she wants in given schedule, competitive price and quality. It is also risk sharing and flexible resourcing Mon, 4/7/08 9:24 AM

9. Right content at right time and with the expected or better quality level. The costs are not overrun. In larger scope I think that deep co-operation is crucial to really get the benefits out from collaboration. For example strategy sharing between different companies in several organizational levels is important. Thu, 4/3/08 3:00 PM

10. Transparent win-win oriented partnership with trusted professionals. Thu, 4/3/08 9:23 AM

11. Reduce cost and optimize resources available to you. Capitalize on the skill sets available outside your own company. Thu, 2/28/08 1:28 PM

12. Success is when customer and supplier are able to form a mutually beneficial relationship, which gives the customer a competetive edge and enables customer long term sustainable growth Wed, 2/27/08 10:24 AM

13. - Continued predictability on schedule & quality, meeting time to market requests consistently - Competitive pricing - Clear interfacing - Scalability, ability for quick ramp up - product development ownership and ability to move up the value chain - Both parties thinking Win-Win and long term.. Mon, 2/25/08 6:17 PM

14. If the relationship sustains over several years, if there is repeat business from customer and if the relationship is viewed as strategic nd not transactional by both parties and gets the mind share of the top management from both the companies. Thu, 2/21/08 4:24 PM

15. Good quality software delivered as per planned schedule

MOST SUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most successful? What was the most important factor that was affecting this choice?

1. We have had responsible for the R&D activities to that product.
2. Expertise (Both Technical and Managerial) from both sides worked from the beginning to work towards the end product. This helped in matching the expectations and early resolution of conflicts
3. Financial outcome, fluent and open co-operation, ease of buying/selling. Most important: fluent and open collaboration

4. When the both parties were looking for a win-win situation the collaboration works. But if the customer is just looking for cost cutting the collaborator becomes just a resource pool that is sacrificable whenever needed.
5. Long term profitability
6. Easy to co-operate, discuss etc. even from difficult things (especially in the past) ; Business has grown during the years
7. Reliability in delivery
8. I think it is successful when the value of collaboration has increased during these 6 years.
9. There was open communication and real risk&reward sharing attitude
10. It was a win–win situation where the needs to reduce OpEx cost of collaborator and need to enhance business volumes with healthy profits in long term of us were met.
11. Trust between parties and size of relationship
12. It was designed to be strategic right from the beginning and had full attention of top management from Day One
13. More business growth for us, so that means collaborator has more trust in us

MOST UNSUCCESSFUL COLLABORATION CASE YOU HAVE PARTICIPATED

Why did you identify this collaboration as most unsuccessful? What was the most important factor that was affecting this choice?

1. We could not get bigger responsibilities and increase our business in that area.
2. NO key technical architecture specialist from customer side who had the vision of the product
3. Resource hiring...
4. Profitability due to unrealistic planning and changing requirements.
5. The roadmaps, targets, business calculation which was given to us were totally misleading
6. The visibility to the targets too weak.
7. Low quality specifications - there are not known what it should be. Totally black box. No way to interact early enough. Wrong method and technology used.
8. Lack of giving ownership to us by customer
9. It was T&M with no sense of ownership

APPENDIX 3: ANOVA results

Model							Welch's ANOVA	
Dependent variable	Independent variable	Group	df	SS	MS	R Square	F	Pr>F
Succ	h	OEM	4	15.014	3.754	0.082	0.23	0.8757
		SUPP	5	48.043	9.609	0.172	2.78	0.1113
Succ	risk_01	OEM	3	16.957	5.652	0.092	0.62	0.5476
		SUPP	4	63.747	15.937	0.228	0.43	0.7333
Succ	risk_02	OEM	3	11.208	3.736	0.061	0.84	0.4975
		SUPP	4	33.440	8.360	0.120	3.55	0.0174
Succ	risk_03	OEM	3	3.436	1.145	0.019	0.22	0.8786
		SUPP	4	44.878	11.219	0.160	1.10	0.3658
Succ	risk_04	OEM	4	29.413	7.353	0.160	2.06	0.1361
		SUPP	4	42.049	10.512	0.150	0.99	0.4112
Succ	risk_05	OEM	3	8.808	2.936	0.048	0.66	0.5877
		SUPP	4	40.835	10.209	0.146	0.22	0.8836
Succ	risk_06	OEM	4	21.293	5.323	0.116	0.09	0.9167
		SUPP	4	20.805	5.201	0.074	1.38	0.2706
Succ	risk_07	OEM	3	7.492	2.497	0.041	0.58	0.6326
		SUPP	4	29.654	7.413	0.106	2.75	0.0494
Succ	risk_08	OEM	3	22.179	7.393	0.121	2.20	0.1219
		SUPP	4	34.077	8.519	0.122	0.24	0.8650
Succ	risk_09	OEM	4	12.016	3.004	0.065	0.28	0.8365
		SUPP	4	72.470	18.117	0.259	2.47	0.0794
Succ	risk_10	OEM	3	2.149	0.716	0.012	0.14	0.9314
		SUPP	4	64.267	16.067	0.230	1.21	0.3239
Succ	risk_11	OEM	4	8.492	2.123	0.046	0.35	0.7904
		SUPP	4	74.005	18.501	0.265	1.29	0.2932
Succ	risk_12	OEM	3	75.208	25.069	0.410	0.30	0.5933
		SUPP	4	77.229	19.307	0.276	2.13	0.1164
Succ	risk_13	OEM	3	24.206	8.069	0.132	2.73	0.0768
		SUPP	4	73.484	18.371	0.263	0.72	0.5520
Succ	risk_15	OEM	3	15.183	5.061	0.083	1.21	0.3491
		SUPP	4	42.452	10.613	0.152	2.94	0.0603
Succ	risk_23	OEM	3	11.668	3.889	0.064	0.91	0.4578
		SUPP	4	22.156	5.539	0.079	1.43	0.2620
Succ	risk_24	OEM	3	12.773	4.258	0.070	0.92	0.4687
		SUPP	4	26.241	6.560	0.094	1.77	0.1644
Succ	risk_25	OEM	4	14.662	3.665	0.080	0.95	0.4458
		SUPP	4	35.467	8.867	0.127	2.62	0.0531
Succ	risk_26	OEM	4	29.644	7.411	0.161	1.57	0.2874
		SUPP	4	1.570	0.287	0.106	2.10	0.1045
Succ	risk_27	OEM	4	31.216	7.804	0.170	2.24	0.1272
		SUPP	4	55.420	13.855	0.198	5.33	0.0028
Succ	risk_28	OEM	4	18.544	4.636	0.101	0.99	0.4575
		SUPP	4	36.814	9.204	0.132	3.04	0.0312
Succ	risk_29	OEM	4	5.948	1.487	0.032	0.25	0.8986
		SUPP	4	64.156	16.039	0.229	8.74	<.0001
Succ	dec_01	OEM	3	16.957	5.652	0.092	0.62	0.5476
		SUPP	4	63.747	15.937	0.228	0.43	0.7333
Succ	dec_02	OEM	3	22.843	7.614	0.124	0.72	0.0404
		SUPP	4	10.742	2.686	0.038	0.76	0.5589
Succ	dec_03	OEM	4	8.123	2.031	0.044	0.23	0.8702
		SUPP	4	7.257	1.814	0.026	0.42	0.7926

Succ	dec_05	OEM	4	15.297	3.824	0.083	0.56	0.6477
		SUPP	4	12.081	3.020	0.043	0.73	0.5803
Succ	dec_06	OEM	4	24.807	6.202	0.135	1.51	0.2693
		SUPP	4	15.282	3.820	0.055	0.94	0.4563
Succ	dec_07	OEM	4	17.735	4.434	0.097	1.03	0.4372
		SUPP	4	23.121	5.780	0.083	2.66	0.0506
Succ	dec_09	OEM	4	19.195	4.799	0.105	1.16	0.3762
		SUPP	4	18.282	4.570	0.065	1.06	0.4002
Succ	dec_10	OEM	4	14.880	3.720	0.081	0.70	0.6227
		SUPP	4	19.642	4.910	0.070	1.18	0.3467
Succ	dec_12	OEM	3	6.057	2.019	0.033	0.24	0.7880
		SUPP	4	20.658	5.165	0.074	1.08	0.4152
Succ	dec_14	OEM	2	16.986	8.493	0.092	2.16	0.1347
		SUPP	4	24.457	6.114	0.087	1.44	0.2531
Succ	dec_15	OEM	3	6.690	2.230	0.036	0.34	0.7119
		SUPP	4	40.763	10.191	0.146	3.01	0.0396
h	dec_01	OEM	3	7.086	2.362	0.088	1.58	0.2284
		SUPP	4	19.575	4.894	0.192	4.42	0.0070
h	dec_02	OEM	3	12.656	4.219	0.158	3.20	0.0624
		SUPP	4	22.588	5.647	0.222	6.28	0.0012
h	dec_03	OEM	4	5.873	1.468	0.073	0.53	0.6825
		SUPP	4	22.393	5.598	0.220	4.77	0.0039
h	dec_05	OEM	4	7.103	1.776	0.089	0.88	0.5283
		SUPP	4	27.299	6.825	0.268	12.10	<.0001
h	dec_06	OEM	4	11.370	2.843	0.142	1.45	0.2825
		SUPP	4	19.047	4.762	0.187	4.22	0.0079
h	dec_07	OEM	4	8.191	2.048	0.102	1.28	0.3405
		SUPP	4	21.079	5.270	0.207	5.47	0.0018
h	dec_09	OEM	4	15.480	3.870	0.193	1.62	0.2393
		SUPP	4	1.620	0.239	0.055	1.00	0.4275
h	dec_10	OEM	4	10.338	2.585	0.129	1.55	0.3028
		SUPP	4	5.500	1.375	0.054	0.91	0.4755
h	dec_12	OEM	3	12.736	4.245	0.159	0.31	0.5841
		SUPP	4	8.093	2.023	0.080	2.13	0.1473
h	dec_14	OEM	2	13.005	6.502	0.162	4.69	0.0184
		SUPP	4	18.695	4.674	0.184	4.60	0.0072
h	dec_15	OEM	3	14.534	4.845	0.181	6.24	0.0062
		SUPP	4	24.204	6.051	0.238	5.68	0.0023
h	risk_01	OEM	3	8.913	2.971	0.111	1.90	0.1974
		SUPP	4	24.675	6.169	0.242	8.98	<.0001
h	risk_02	OEM	3	16.164	5.388	0.202	7.19	0.0056
		SUPP	4	24.582	6.145	0.242	10.53	<.0001
h	risk_03	OEM	3	10.391	3.464	0.130	1.92	0.1926
		SUPP	4	14.579	3.645	0.143	4.64	0.0045
h	risk_04	OEM	4	6.235	1.559	0.078	0.76	0.5821
		SUPP	4	7.143	1.786	0.070	2.30	0.0866
h	risk_05	OEM	3	13.009	4.336	0.162	2.88	0.0637
		SUPP	4	9.344	2.336	0.092	3.21	0.0277
h	risk_06	OEM	4	4.081	1.020	0.051	0.69	0.5692
		SUPP	4	12.678	3.169	0.125	2.21	0.0969
h	risk_07	OEM	3	5.071	1.690	0.063	0.95	0.4348
		SUPP	4	9.800	2.450	0.096	2.01	0.1230
h	risk_08	OEM	3	8.880	2.960	0.111	2.64	0.0801
		SUPP	4	20.750	5.187	0.204	6.44	0.0011
h	risk_09	OEM	4	2.230	0.557	0.028	0.52	0.6765
		SUPP	4	6.445	1.611	0.063	1.10	0.3787

h	risk_10	OEM	3	2.581	0.860	0.032	0.64	0.5966
		SUPP	4	12.187	3.047	0.120	3.23	0.0267
h	risk_11	OEM	4	1.432	0.358	0.018	0.19	0.9026
		SUPP	4	9.752	2.438	0.096	1.88	0.1414
h	risk_12	OEM	3	8.523	2.841	0.106	1.61	0.2204
		SUPP	4	7.680	1.920	0.075	1.24	0.3155
h	risk_13	OEM	3	7.806	2.602	0.097	1.28	0.3168
		SUPP	4	2.098	0.525	0.021	0.34	0.8491
h	risk_15	OEM	3	0.890	0.297	0.011	0.11	0.9541
		SUPP	4	8.949	2.237	0.088	2.67	0.0724
h	risk_23	OEM	3	11.093	3.698	0.138	2.85	0.0700
		SUPP	4	10.696	2.674	0.105	1.94	0.1419
h	risk_24	OEM	3	15.360	5.120	0.192	3.72	0.0456
		SUPP	4	17.145	4.286	0.168	3.51	0.0192
h	risk_25	OEM	4	4.109	1.027	0.051	0.75	0.5381
		SUPP	4	8.548	2.137	0.084	1.92	0.1316
h	risk_26	OEM	4	3.579	0.895	0.045	0.28	0.8802
		SUPP	4	6.697	1.674	0.066	1.01	0.4150
h	risk_27	OEM	4	5.227	1.307	0.065	1.46	0.3066
		SUPP	4	7.900	1.975	0.078	1.84	0.1514
h	risk_28	OEM	4	8.180	2.045	0.102	1.72	0.2164
		SUPP	4	4.443	1.111	0.044	0.72	0.5815
h	risk_29	OEM	4	0.885	0.221	0.011	0.10	0.9585
		SUPP	4	5.771	1.443	0.057	0.90	0.4776
dec_01	risk_10	OEM	3	3.844	1.281	0.117	1.19	0.3487
		SUPP	4	37.753	9.438	0.239	7.69	0.0003
dec_02	risk_03	OEM	3	2.496	0.832	0.082	1.25	0.3495
		SUPP	4	43.423	10.856	0.237	4.61	0.0052
dec_03	risk_09	OEM	4	6.530	1.632	0.152	1.02	0.4756
		SUPP	4	25.115	6.279	0.152	2.58	0.0607
dec_05	risk_05	OEM	3	5.448	1.816	0.098	1.83	0.1782
		SUPP	4	20.197	5.049	0.173	2.96	0.0413
dec_05	risk_04	OEM	4	3.875	0.969	0.070	0.68	0.6248
		SUPP	4	17.673	4.418	0.151	2.43	0.0803
dec_14	risk_27	OEM	4	5.187	1.297	0.153	1.18	0.3512
		SUPP	4	41.501	10.375	0.285	12.45	<.0001
risk_03	dec_02	OEM	3	2.144	0.715	0.056	1.01	0.3833
		SUPP	4	25.873	6.468	0.205	3.45	0.0198
risk_05	dec_03	OEM	4	5.693	1.423	0.130	2.13	0.1958
		SUPP	4	25.224	6.306	0.240	5.94	0.0013
risk_09	dec_03	OEM	4	5.416	1.354	0.099	0.61	0.6366
		SUPP	4	14.886	3.722	0.123	1.85	0.1435
risk_10	dec_01	OEM	3	3.831	1.277	0.086	0.45	0.6420
		SUPP	4	29.005	7.251	0.261	5.85	0.0014